HEATING & VENTILATING

For Engineers and Contractors Controlling the Design, Specification, Installation and Maintenance of Heating, Ventilating and Air Conditioning

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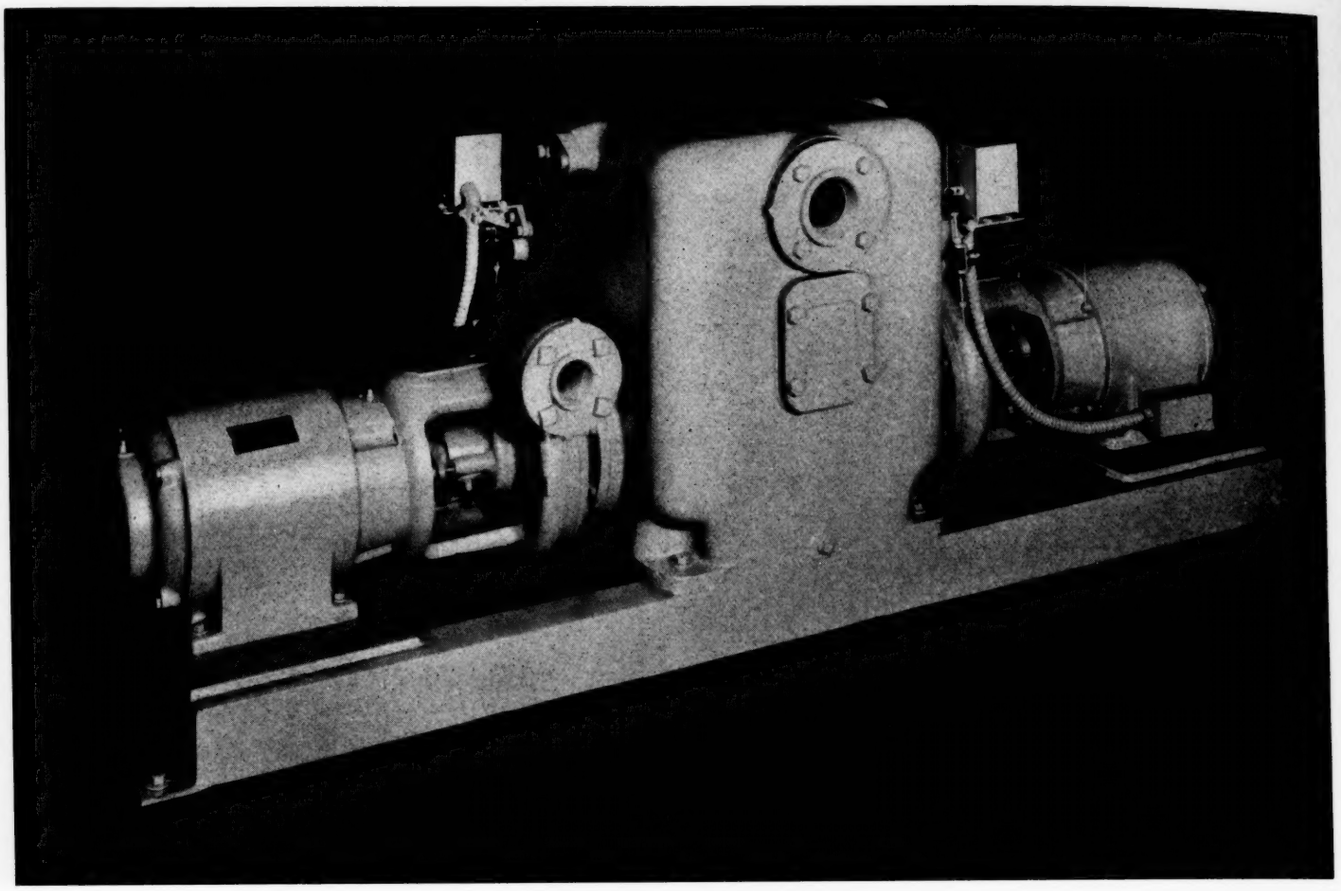

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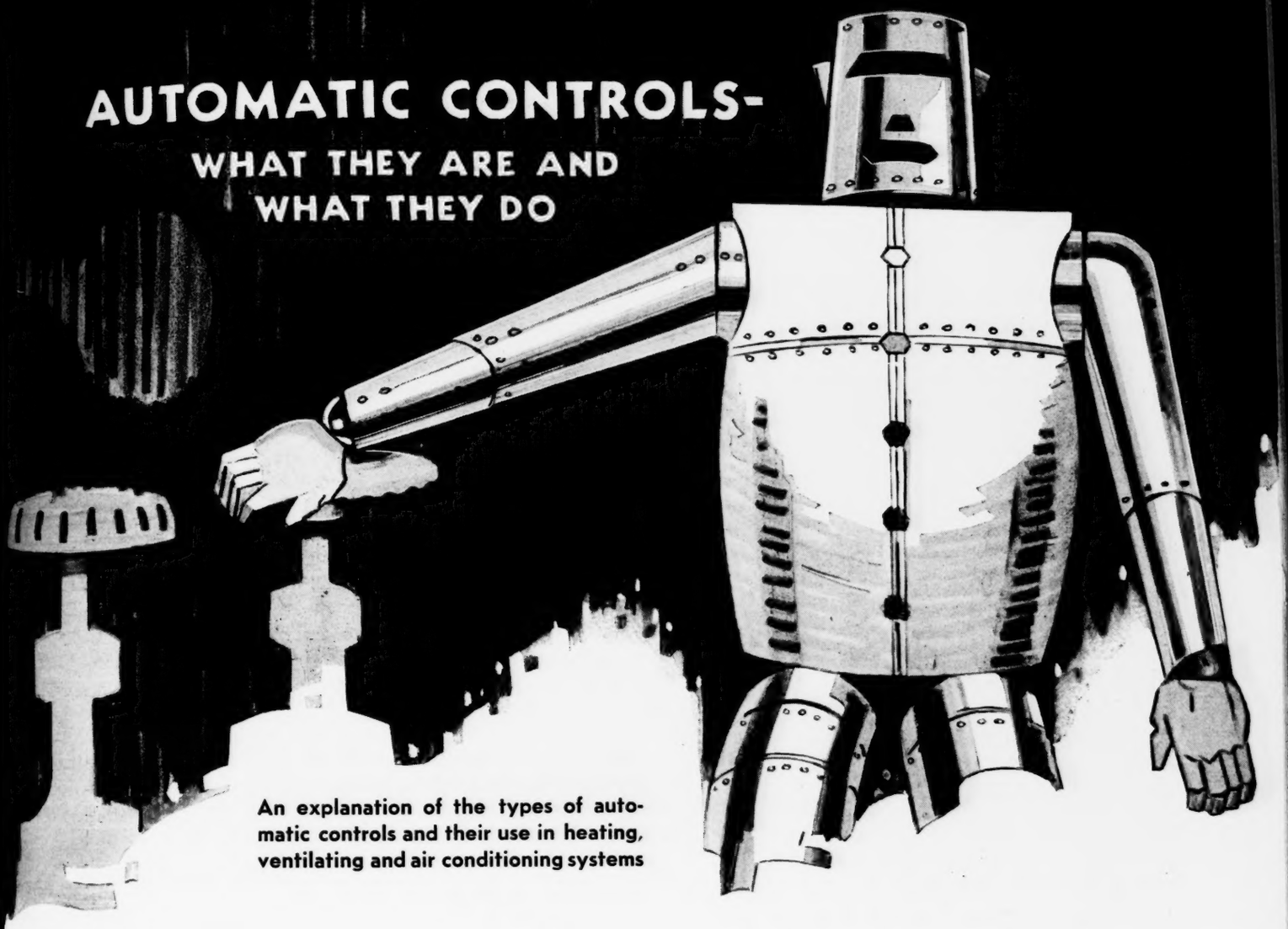
AUTOMATIC CONTROLS-
WHAT THEY ARE AND WHAT THEY DO



An explanation of the types of automatic controls and their use in heating, ventilating and air conditioning systems

WITH the automatic controls now available it is possible to secure operating results not attainable by manual means. While such a statement may seem sweeping it is nevertheless substantially correct. For instance, take the case of temperature or humidity sensitive devices. These devices react to changes before these changes become apparent to an attendant usually distracted with a multitude of other duties, as it is almost never practical to assign a manual operator to each control point.

In some fields the desirability of accurate and dependable automatic operation is much more generally recognized and applied than in others. Modern power generating plants, for example, usually go the limit and use automatic devices wherever they can be shown to be even reasonably justified. In many factory operations manual control is no longer tolerated. Automatic devices have made spectacular advances in acceptance in connection with combustion control in heating plants, especially in residences, because of their convenience. In commercial buildings full automatic control is gaining rapidly in favor because of demonstrated operating savings.

In installations where there is a central fan and ducts, automatic controls have been in common use for years. For heating or ventilating purposes the methods of application and the results desired and obtainable are fairly well standardized. When air conditioning installations are under consideration, however, there seems to be a lack of understanding both of what equipment is available and of how it can be satisfactorily applied, in spite of the fact that much of the equipment is itself familiar and that central fan and duct installations for air conditioning are closely similar to the older and better understood arrangements for heating or ventilating or for heating and ventilating combined.

It is the purpose of the present series of articles to list and define the classes of equipment which go to make up automatic control installations and to show by diagrams how these items of equipment can be combined to meet the problems encountered in central fan installations for heating and ventilating and for air conditioning. As the arrangements for heating and ventilating are older and better known, the method used will be to start with simple requirements and show how the simple control arrangements are modified as the requirements become more complex. Then it will be shown that controls for unit systems are essentially the same as those used for central systems.

A second consideration in preparing these articles is that automatic control for air conditioning should be considered just as necessary as any other parts of the installation and should be given careful and adequate consideration when the plans are being made. They should not be considered as an accessory subject, for

if properly selected and applied they will make satisfactory operation possible, while if neglected or thoughtlessly omitted the purchaser may in no wise get the results which he both expects and is entitled to receive from a modern job.

Before proceeding with definitions let us analyze the situation to some slight extent.

It is helpful to keep clearly in mind that practically all installations of automatic controls whether the job be exceedingly simple or extremely complex are made up from a skillful and proper selection and combination of a few kinds of equipment. The number of designs and the number of items of special equipment available are bewildering and the one who does the selecting must be most careful that he fully understands both his problem and the correct operation and limitations of each item if he expects satisfactory operation. In a case where there is any degree of complexity most designers will want exact information, and perhaps help, in selection. He probably will need performance information from the control manufacturer and it is believed that such a procedure is desirable. However, this situation does not make it any the less desirable to keep the fundamental equipment classes in mind. These are:

1. Automatic sensitive elements (controllers)
2. Power units
3. Valves and dampers (the controlled equipment)
4. Connectors
5. Accessories

Automatic Sensitive Elements

These elements are so constructed that they are sensitive to small changes and are the apparatus where the controlling impulse starts a chain of movements or impulses which ultimately results in the desired control being achieved. We can define them as follows using the names most commonly given to them.

Thermostats are devices sensitive to changes in the air temperature in the rooms in which they are placed.

Temperature controllers are all other temperature sensitive control devices except thermostats as just defined.

Humidity controllers are sensitive to changes in humidity, and commonly they react to changes in relative humidity. They may be constructed and applied so that they can be used to either limit relative humidity or to regulate it between limits. These controllers can be so installed that they limit or regulate either humidification or dehumidification equipment.

Pressure controllers react to changes in pressure or to pressure. These devices are capable of being so constructed that they can either limit pressures or can regulate pressure. They find use in starting and stopping refrigeration compressors, air compressors, fans, and similar equipment.

Liquid level controllers are sensitive to changes in liquid heights or levels.

Limit controls: It is so often desirable to use automatic controls to prevent operation outside of predetermined limits that controls of this type need mention and definition.

In general, operating control within a range of limits or at some one fixed limit can be accomplished by suitable planning, using the same classes of equipment previously mentioned. Limit control does not therefore generally require a separate design of equipment but refers rather to the function which the equipment fulfills. By *limit controls* are meant any of the controllers previously listed which are so applied that their primary function is to prevent operation outside of predetermined limits. When the predetermined limit is set at some maximum point the control is called a *high limit control,* while when the limit is fixed at some minimum point we have a *low limit control.* For example, suppose it is decided that the air temperature at a central fan discharge must never exceed 125°, an automatic control arranged to limit the temperature to this value would be a high limit control.

Discussion or description of the great diversity of forms and designs in which all these sensitive elements are available on the market is not necessary here where the intent is to simplify rather than to aim at completeness of discussion. Everyone even remotely familiar with automatic control equipment is fully aware of the great range of choice which is available in selecting these sensitive elements.

An additional point which should be noted is that these sensitive elements can be and are so constructed that the impulse which they set up can be transmitted to other controlled equipment either along electric circuits, compressed air circuits, through mechanical connections such as levers or chains, or by means of liquid or vapor pressures. These elements can also be so arranged and constructed that their own change in shape or form directly accomplishes the desired control. Moreover, they can be so constructed that they permit a wide difference in the characteristics of the motion or impulse which they transmit. This great flexibility gives rise to some other terms in connection with automatic controls which will be defined in later papagraphs.

Power Units

The essential function of this class of equipment is to furnish a device which when suitably connected to the sensitive element and to the controlled equipment permits or causes the latter to take such a position that the desired control is accomplished.

In their commonest form these devices are motors either electric or compressed air powered. As such they have two common applications, viz., to actuate air dampers and to move valve stems. In another form the power unit may be an electric solenoid such as is often attached to the stems of valves. In still other cases these power units serve to position dampers in flues, breechings, or ashpit doors.

The principal classes of these power units can be thus listed and defined.

Damper motors, a specialized form of unit constructed to operate dampers, or more specifically to *position* dampers.

Valve motors, for attaching or linking to the stems of control valves.

Solenoids, power devices giving straight-line movement and often attached to control valves.

Valves and Dampers

Valves for use with automatic controls are essentially the same in function as are hand-operated valves, i.e., are a means of stopping, starting, or regulating flow of fluids including air, steam, or water.

Control valves may be defined as those which are adjusted by or under the command of automatic sensitive elements to regulate the flow of the material passing through them in such a way as to meet the needs of the system. These valves are usually so designed that a power unit is attached to the valve stem to position them in accordance with the commands of a controller. The valve stem thus changes its position as the needs of the system vary. Control valves are built in such a variety of styles and patterns and for such specialized applications that any attempt to mention all of them would be almost endless. Among those commonly used in air conditioning and heating work are the following ones:

Radiator valves for attaching to the inlets of individual radiators to regulate the flow of low pressure steam or hot water to the radiator. They are *self-contained radiator valves* if they are actuated by a temperature sensitive element built into them, and are *remote controlled radiator valves* if the temperature sensitive element is remote from the valve.

In *solenoid valves* the power unit is a solenoid energized under the command of a controller. Commonly they are so constructed that the valve is opened when the solenoid is energized, but are also capable of being so built that the valve closes when the solenoid is energized. These valves are limited in size and are much used as control valves for oil and other fuel lines, on small humidifiers, as refrigerant valves in refrigeration lines, and as pilot or relay valves in the operation of large diaphragm valves.

In *diaphragm valves* the power to move the stem is derived from pressure acting on the diaphragm surface and the pressure varies under the command of a controller. Valves of this kind are available in great variety to meet specialized requirements.

Dampers are so well known that it seems unnecessary either to describe or define them. They are available as required but usually must be made up to fit each particular job in central fan installations.

Connectors

The fact that necessary electric wiring, compressed air piping, or conduit or tubing for transmitting pressure changes must be available is self-evident. All these are commonly items of standard manufacture and are designed and installed in accordance with the usual rules and standards.

Accessories

In order that particular devices may operate as intended or to meet particular requirements, various accessories are needed. Among these may be mentioned switching equipment, which may be operated either manually or automatically, gauges, meters, tell-tale indicators, instrument boards, and relays. Of these items nearly all are so well known in function that detailed mention need not be made of them.

In the case of electric *relays* their function is perhaps not so well understood. They are a device installed between a controller and the controlled equipment to amplify the capacity of the controller in the degree required by the load on the controlled equipment. Thus, considerable power may be required to move a certain valve stem while it is at the same time desirable to preserve sensitiveness of operation on the part of a thermostat. In such a case a low power electric circuit could lead from the thermostat to a suitable relay. The low power circuit would then actuate the relay and the relay would in turn actuate the valve stem.

Regulating Controls

Automatic control equipment available on the market is capable of being so arranged that the controllers can impart movements of several distinct kinds to the controlled equipment (the valves and dampers). The kind of movement set up gives rise to a classification of control methods. Three principal methods can be recognized as

(a) Two-position control
(b) Modulating control
(c) Floating control

Ordinarily equipment intended to accomplish regulation by any one of these methods is not suitable for use with either of the other two. However, this should not be interpreted to mean that on a given installation only one of these methods of control can be used. As a matter of fact on a complex installation particular operations may be accomplished by one method while another method is used to accomplish another operation. Thus, in the same building two-position control might be used to open and close a valve on the steam line to a preheater coil, while modulating control would be used to position a damper. Each method of control lends itself especially well to certain operations while it is not at all well suited to others. This can be made clear by considering each of these methods separately.

Two-position control, also sometimes called "on and off," "start and stop," and "positive acting," is distinguished by the fact that as a result of the action of the controller the controlled equipment takes on but one of two possible positions.

Where it can be used, two-position control is generally the simplest method of providing regulation. However, it has limitations. For example, if used to regulate a louver type face and bypass damper in connection with a heating coil this method of control would pass all of the air through the heater or all of the air around the heater. Thus the air discharged would vary sharply in temperature and this might be undesirable. Such an operation would be better handled by some other method of control. On the other hand, in a preheating coil, when steam is admitted, normal practice is to open the steam valve completely, and when tempering is not required, the steam valve is completely closed. This is a complete two-position control cycle and is adequate to the requirement.

Modulating control, also sometimes called "graduated" and "proportional," is distinctive in that the con-

trolled valve or damper proportions the flow of air, steam, or water in reacting to changes at the controller. Motion in the controlled device is proportional to motion caused in the controller by fractional degree variations in the medium to which the controller is responsive. The valve or damper is repositioned as often as changes occur at the controller and always in direct proportion to the amount of the controller change.

A heating coil with face and bypass damper, damper motor and thermostat can serve as an example. Assume the thermostat to be set to the range of 70° to 72°; at 72° the face damper will be closed. If the temperature drops fractionally, say 1/10° to 71.9°, the modulating damper will cause the face damper to open 1/20 or 5% of its total movement. If the drop in temperature has been ½°, i.e., to 71.5°, the damper would have opened 25% of its total possible travel. After each such change, the damper will stand still awaiting the next movement at the thermostat.

Floating control refers to the method in which the controlled device will, upon changing the extreme limits of the controller setting, come to rest only when the temperature has stabilized between these limits.

Again the case of the heating coil and the face and bypass damper can be used as an illustration. Assume a room thermostat at whose command the damper motor operates. With this method of control the temperature in the room may be held between 70° and 72° because of the following operation of the controls. When the room temperature drops to 70° the damper motor starts, opening the damper, which passes air through the heating coil and at the same time reduces the area of the damper through which the air is bypassed around the coil. The air delivered will therefore be heated, but the damper motor will continue to open up the coil face damper and close the bypass damper until it has reached either the full open position or until a contact in the thermostat is broken. As the temperature is now somewhere between 70° and 72°, there will be no further operation of the damper motor and, accordingly, of the dampers until the temperature either drops to 70° again and further opens the dampers or until the temperature increases to 72°, when the operation of the damper motor reverses. Thus floating control causes this damper to float whenever the temperatures surrounding the controller close the actuating contacts at the predetermined high and low temperature limits.

Skyscraper Adds 1½ Floors to A. C. System

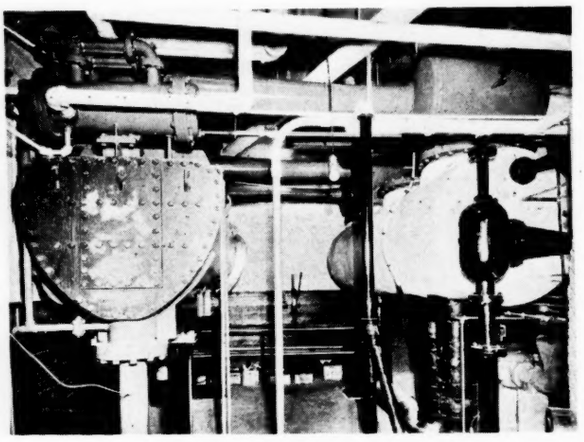
So satisfactory were results after one year's use that the New York Trust Co., New York, increased the capacity of the steam jet air conditioning system in its 43-story office building by one and a half floors during the past summer. This makes eight and a half floors, with 85,000 sq. ft. of floor area now conditioned.

The structure was modernized last year and the agents shortly thereafter received an offer of lease for six entire floors provided the owners installed air conditioning. This was done, with the seventh to twelfth floors conditioned for lease and with the sixth floor conditioned for the agents. Expansion to cover the thirteenth floor and half of the fifth floor was made in July, 1935.

Floors were cut to receive air distributing riser ducts. Branch lateral ducts extend across the ceilings of all floors conditioned and are exposed throughout. The owners state that further extensions to the system would be ordered were it not for structural restrictions, this having to do chiefly with the roof, where it would be necessary to install one or more water cooling towers. Were towers so placed and of the required size it would be necessary to strengthen the roof and possibly necessitate removal of at least one penthouse. As these are readily leased at premium prices, this might not be profitable.

The main fan, spray type cooler, and accessories are located in a fan room, formerly an office, on the seventh floor. The total air volume handled in the system is over 78,000 c.f.m.

A 270-ton and a 140-ton steam jet are used for cooling the water, steam being supplied by the local steam utility. Full automatic control governs all functions.



Steam jet air conditioning equipment in New York Trust Company Building, New York, which cools eight and a half floors. Condenser is shown at left with the jet above and the evaporator at the right.

When the air conditioning system is operated refrigeration costs 6 cents per ton, according to George J. Falkner, building superintendent.

Ordinarily one 70-ton and one 40-ton jet are in operation, with the other 70-ton jet being used in extremely hot weather. Steam costs run about $3 per hr. Hot weather power requirements total 140 kw. per hr. at an average cost of 2¾ cents per kw-hr.

Office of the Secretary of the Treasury.

Cooling Tower Inside, Machinery Room Outside in Air Conditioning of U. S. Treasury

By LOUIS K. BERMAN† and PAUL K. GERHARDT‡

TWO unusual features are incorporated in the air conditioning system installed in the Treasury Building in Washington by the Raisler Heating Company of New York. These features are a large indoor cooling tower capable of supplying cooling water for 500 tons of refrigeration and a large machine room or vault, 35 x 68 x 20 ft. high, buried 5 ft. underneath the front lawn.

The Treasury Building is one of the oldest and best known of the many government buildings in Washington. The main section was erected approximately 100 years ago during President Jackson's term. An addition called the "new section" was built in 1861. As is to be expected, all the walls are thick masonry, making changes and cutting extremely expensive.

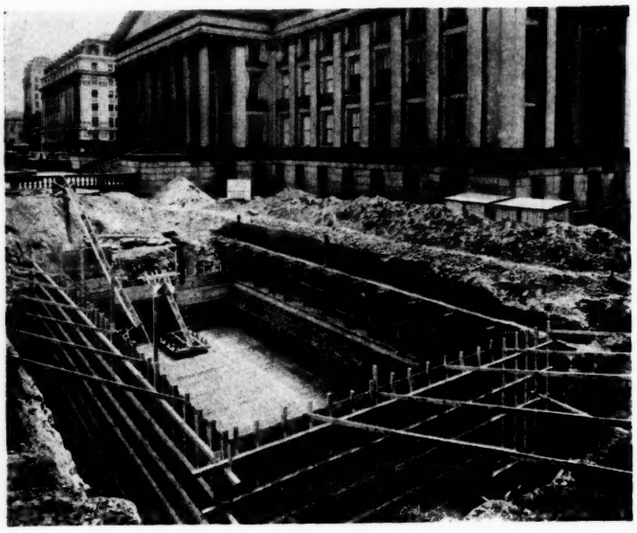
There are very few interior doors in the building and where there are doors they are mainly made up of wood bars allowing a free flow of air from room to room. This condition was made use of in designing the air distribution system.

The contract called for air conditioning of the basement, first, second, and third floors. The fourth floor had been conditioned previously, using a centrifugal compressor. The system installed is a mechanical one having a central refrigerating room which furnishes cold water to 11 dehumidifiers located in the basement, first, and third floors. The heat removed from the condensing water is exhausted through a large indoor cooling tower located on the fourth floor. The apparatus was designed to maintain 80° dry bulb and 50% relative humidity when the outside conditions were 95° dry bulb and 78° wet bulb. In the winter it is capable of maintaining a 40% relative humidity with a temperature of 70°.

†President, Raisler Heating Co., New York.
‡Chief Engineer, Raisler Heating Co., New York.

Underground Machine Room

The construction of the underground machine room was part of the air conditioning contract. The room is built of waterproofed reinforced concrete with its ceiling 5 ft. below the surface of the lawn. It is connected with the building by means of a pipe tunnel and an emergency exit is provided to the lawn above. After the room had been finished and the lawn replaced, refrigerating apparatus was moved in through the pipe tunnel. The apparatus in this room consists of two compressors and motors, two condensers, two water coolers, a cubical board, indicating panel, two condenser water pumps, two chilled water pumps, and a chilled water return tank.

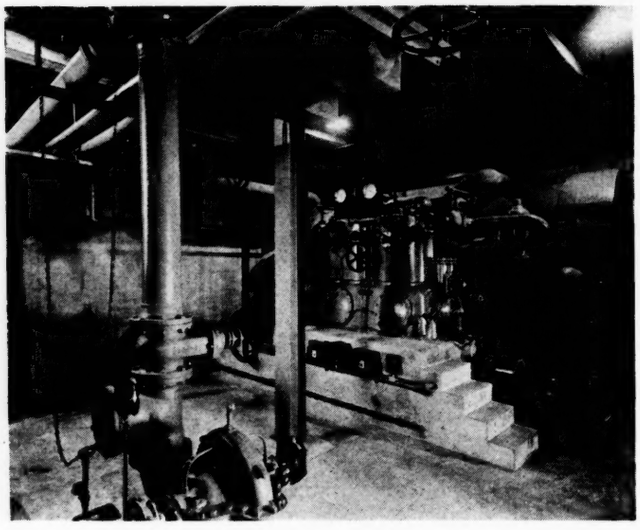


Underground machine room during construction. After completion, it was covered with five feet of earth and the lawn replanted.

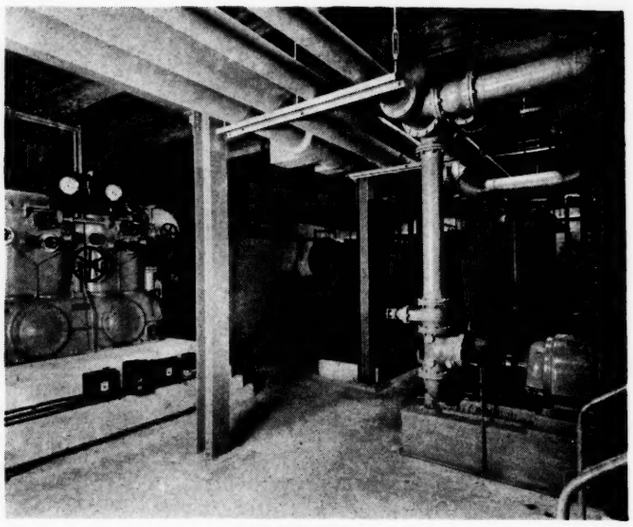
Vault for Air Conditioning Machinery

●

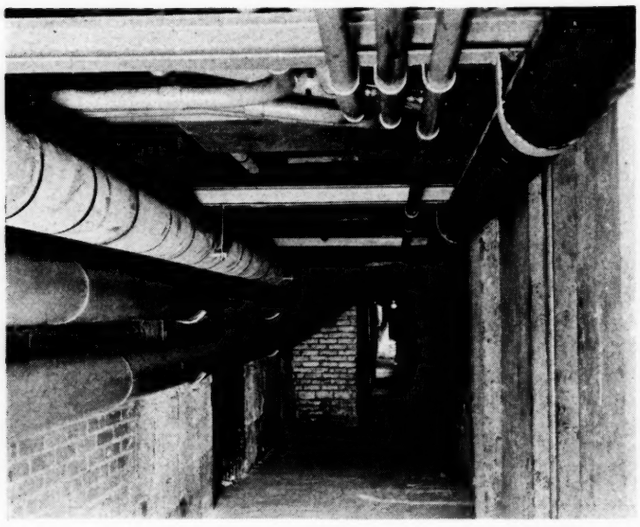
United States Treasury Building
Washington, D. C.



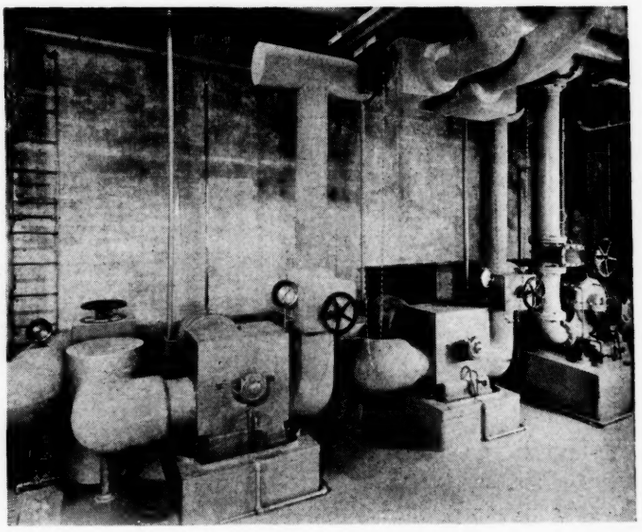
One of the four cylinder vertical compressors used for cooling the Treasury Building. Just behind the compressor are the condenser and chilled water cooler.



Another view of the refrigerating compressor. In the center of the picture is the cubicle board, while at the right are the condenser water pumps.



Pipe tunnel which connects the Treasury Building and the machinery room. The chilled water piping is covered with cork.



Two chilled water pumps which take the water from the storage tank and pump it through the coolers. Pumps are insulated with cork.

Refrigerating Compressors

The refrigerating compressors are of the vertical type, single acting, and have four cylinders. Both have bores of 10 in., one having a stroke of 14 in., and the other 12½ in. The capacity of the compressor with the 14-in. stroke is 300 tons, and the one with the 12½-in. stroke is 200 tons. They are driven by 300-hp. and 225-hp. synchronous motors, respectively. They are directly connected to the motors and driven at a speed of 300 r.p.m.

Alternating current is used by both motors. It is brought into the building from the street at 13,200 volts and stepped down through three 450-k.v.a. transformers to 2,300 volts for the compressor motors. Other transformers supply 208 volts for the other motors in the building. Two motor generating sets are used to supply the direct current necessary for excitation of the compressor motor fields. Manually operated switches are used for starting the compressors.

Condensers

The hot refrigerant gas from each compressor is cooled in a horizontal shell and tube condenser of the multipass closed type. The larger compressor uses a 48½ in. x 16 ft. condenser having 2,260 sq. ft. of surface while the smaller one employs a 43 in. x 16 ft. condenser with 1,782 sq. ft. of surface. The shells are of rolled steel plate and are fitted with 2-in. tubes of hot rolled seamless steel. The heads are bolted to the outside edge of the tube head which extends beyond the shell.

Water Coolers

The water coolers are of the same type of construction but slightly smaller in size and have 1¼-in. tubes. A 300-ton compressor has a water cooler with 2,200 sq. ft. of surface and the 200-ton compressor has one with 1,579 sq. ft. of surface. Both water coolers are located above the condensers and next to the compressors. A refrigerating pump attached to each cooler is used to circulate the refrigerant through it. This considerably improves the efficiency of the system.

Water Supply for Condensers

The water for the condensers is obtained from the large indoor cooling tower located on the fourth floor. Two pumps of 1,400-g.p.m. capacity force the water through the condensers and up to the cooling tower.

Cooling Tower

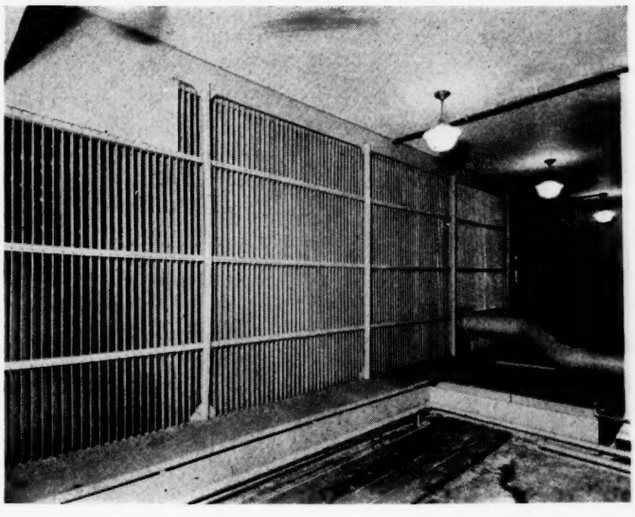
It was necessary to install an indoor cooling tower because the Fine Arts Commission which has the final word on all changes to public buildings ruled that the outlines of the building could not be altered. This made it necessary to install the tower on the fourth floor with a discharge to the roof above. Approximately 222,000 c.f.m. of air is used to cool 2,800 g.p.m. of water from 97° to 90°. Three fans, each driven by a 30-hp. motor, are used to supply this air. The discharge from the cooling tower extends only 12 in. above the roof level.

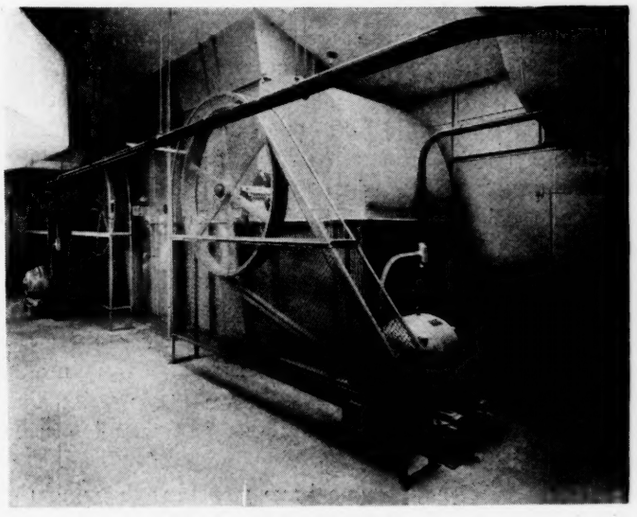
After leaving the sprays, the cooled water is collected in a tank at the bottom of the tower and drops through an 18-in. pipe to a surge tank on the third floor. A perforated baffle located near the top of the tank is used to break the fall of the water. Located in this tank is a float valve which regulates the supply of makeup water to the condenser cooling system. The water then flows by gravity from the surge tank through a 12-in. pipe to the two condenser pumps in the machinery room.

Chilled Water for Dehumidifiers

Spray water which returns from the dehumidifiers is stored in a large return tank in one corner of the machinery room. This tank is 15 ft. long, 8 ft. wide, 9 ft. high, has a capacity of 8,100 gal., and is insulated on the top, bottom, and sides with 4 in. of cork. A 2-in. pipe carries the overflow from the tank to a 10 x 6 x 7½ ft. deep sump pit in the floor of the room. Two sump pumps, each of 250-g.p.m. capacity, remove the water from the pit.

Makeup water for the chilled water system is taken from the street water mains and added to the tank through a hand operated gate valve. The amount of





(Left) Air inlet side of the indoor cooling tower. The pipe shown at the right carries the warm condenser water to the sprays just behind these grilles. (Right) The battery of fans which draw 222,000 c.f.m. of air through the cooling tower and discharge it through an opening in the roof to the outdoors.

(Left) A corner of the transformer room. Current enters the building at 13,200 volts and is stepped down by three of these transformers to 2,300 volts for the compressor motors. (Right) One of the 11 air washers. This one is located on the third floor. The basement washers have pumps returning chilled water to machinery room.

water in the tank is shown by a gage glass running the entire height of the tank. A 4-in. air vent is located at the top of the tank.

Water is drawn from the tank by two 850-g.p.m. pumps which force it through the water coolers. An 8-in. pipe carries the chilled water from the machinery room to the 11 air washers in the building. The water is returned by gravity from all of the air washers, except the three located in the basement. Three pumps are used to return the water from these three units.

Air Washers

It has been noted before that 11 air washers or dehumidifiers are used to condition the first three floors and the basement. Six of these units located on the third floor cool the second and third floors, while two units on the first floor and three in the basement cool the lower floors. All air washers are located in separate fan rooms.

In the typical fan room outside air is drawn through dampers and preheaters into a chamber where it is mixed with the recirculated air. The air then passes through the spray chamber and eliminator plates. Between the eliminator plates and the fan intake is a small chamber with openings on both sides. Dampers in these openings regulate the amount of recirculated air bypassed around the spray chamber.

Steam coils are provided in the outside air intake because the system is used during the winter to supply ventilating air and to regulate the humidity. Extended surface heating coils are also provided in the recirculated air opening to the mixing chamber and in the recirculated air bypass openings to the fan intake. Steam for the coils is obtained from the present high pressure line and reduced to about 5 lb. Condensation is wasted to the sewer.

All air washers but one have two fans drawing the air through them and forcing it to the distribution system. The single exception has three fans and supplies air for three systems. Thus there are 23 distribution systems in all, two for each of the ten air washers and three for the eleventh.

Ducts

Most of the distribution ducts are left exposed although in some cases they are furred and plastered. In the more important rooms 1-in. cork insulation and plaster are used on the ducts.

Air is returned by allowing it to flow through open doorways, along corridors, and through a large grille into the fan room. No ducts are used in returning air to the fan room.

Controls

A compressed air operated control system is used to regulate the temperature and humidity throughout the building. The compressor and storage tank are located in one of the fan rooms. Some of the more important rooms in the building have independent controls which enable the occupants to regulate the conditions in those rooms.

A main indicating board located in the machinery room shows the operation of the system. At the top of this board are four instruments indicating temperature of the chilled water leaving the coolers, and the temperature of the water leaving the condensers. Just below this is a series of red and green lights which show the operation of every motor in the system. When a particular motor is in operation, its green light glows. If the motor circuit is interrupted the red light shows. When motors are stopped all lights are out.

Insulation

Cork insulation of various thicknesses is used throughout for reducing heat flow. All of the chilled water piping is covered with ice water thickness cork. The chilled water return tank is covered with 4 in. of cork board, and 2 in. on the dehumidifiers and 1 in. of corkboard on some of the ducts.

Welding

No screwed or flanged fittings are used in the system. All of the piping has been welded.

Heating A Model Village . . .

ONE of the major tasks in the initial development of the Passamaquoddy Project was to construct adequate housing facilities for the laboring and supervisory employes. Eastport, a city of 3000 located centrally to the many features of the Project although ideally suited in location, lacked facilities for housing the 5,000 prospective new citizens.

Due to the limited sites available (Eastport is located on a small hilly island) barracks were constructed in three locations to provide housing for approximately 1,800 men. Each block unit of 400 was provided with a central mess hall but in other respects buildings were so arranged to contain bunking and connected bath house facilities in units of 100 men each.

This arrangement was deemed the best from the viewpoint of sanitation and most economical from the viewpoint of utilities. Heating in these buildings is by stoves but provision will be made at a later date to provide steam heat from central plants where possible.

Quoddy Village, located about two miles from Eastport but on the Island, is termed a model housing development and will provide homes for the next four years for the many employes who will design, supervise, and construct the many phases of the "Quoddy" Project.

Situated on a wooded slope overlooking Half Moon Cove, one of the numerous arms of Passamaquoddy Bay, Quoddy Village enjoys to the fullest extent one of the most attractive settings in the beautiful state of Maine. The present development consists of some 100 acres, most of which are thickly covered with evergreens, through which have been cleared numerous lanes and a few larger areas, marking the locations of roads and the several larger buildings. In order to retain as much of the natural beauty as possible, clearing has been held to a minimum. Attractive homes are nestled in the trees, almost hidden from view. Later, each home will be studied individually, and the sites landscaped to preserve all the natural beauty.

This modern village is served with water, electric, sewer, and steam conduits, surfaced roads, drainage, street lights—all the necessary adjuncts of an independent city. The layout of the utility trenches is governed largely by topographical and geological con ditions, the sewer, water and steam conduits being located in general in a common trench. This condition is rendered necessary by the great amount of expensive rock construction encountered.

Heating System

In general, the complete heating system can be briefly described as a network of underground conduit spreading fanwise over the 100-acre site, the central heating plant being located on the periphery of the fan, at an elevation of about 20 ft., mean sea level. Elevation of the 129 buildings served range from this low plane up to an elevation of 90 ft., or approximately the elevation of the heater house provided for the 200,000-gal. water storage tank located at the high spot of the village. The buildings constituting this model town, all of which are heated by the central plant, include 55 single homes, 35 duplex homes, 30 of the four-family type, two 40-family apartments, an 80-room dormitory, and other large buildings for administration, hospital, school, reproductions laboratory, fire station housing, and the central boiler plant and electric generator plant. All of the buildings are of frame construction, insulated, except the boiler house, which is of structural steel, sheet metal and concrete. Because of the central heating feature, basements are eliminated, with the exception of apparatus pits in the larger structures for convenient access to the various utility connections.

Central Heating Plant

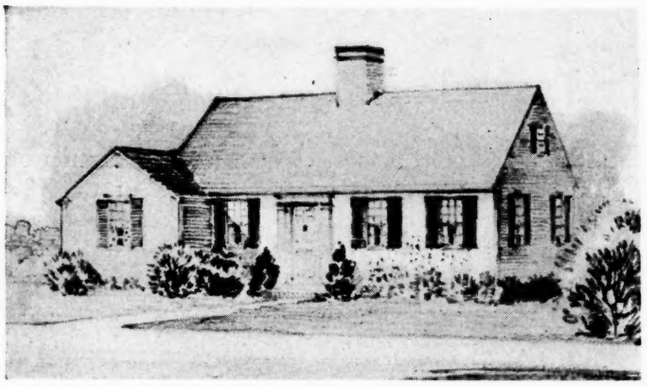
The boiler plant consists of a standard practice oil burning three-boiler unit, with all the accessory equipment necessary for heating and pumping oil, firing the boilers, reclaiming condensate, and operation of pneumatic control system. Housed in an all-steel building, connected with breeching to a 125-ft. steel stack, the structure represents an economical design and interesting solution of the heating problem. Two of the boilers are 17 tubes wide, of 301 hp., while the other, 9 tubes wide, is of 160 hp. All boilers are oil fired. It is interesting to note that, though most of the distribution system required rock excavation, the site of the boiler house itself, on soft foundation material, necessitated

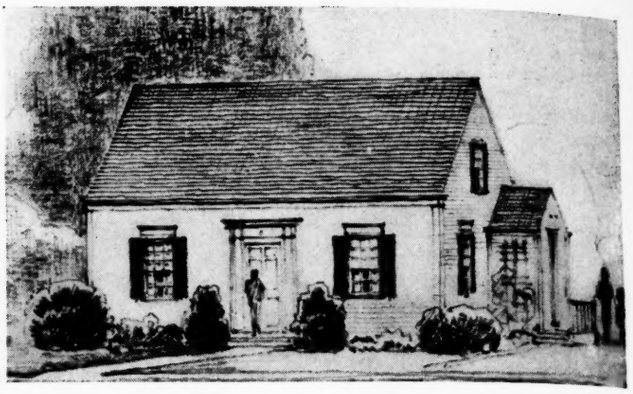
THE PASSAMAQUODDY PROJECT— POWER FROM THE TIDES

One of the most interesting projects undertaken during the past few years by the federal government is the construction of the Passamaquoddy Tidal Power Project which will generate power from the rise and fall of the tides. The center of the project is close to the present town of Eastport, Me.

In order to generate the power a series of dams will be built which will cut off Cobscook Bay from the Bay of Fundy and change it into a huge low level pool of 37 square miles area. When the tide is at its lowest level huge gates connecting Cobscook Bay with the Bay of Fundy will be closed cutting off the former from the Bay of Fundy. As the tide in the latter rises and the difference in head between the sea and the basin exceeds 5 ft., the power house will be opened and power generated from the rising tide. The mean range of the tide in this locality is about 18 ft. Generation of power is continued during the falling tide until the difference in head between the sea and the basin again reaches 5 ft. When the elevation of the sea reaches that of the basin, the emptying gates will be opened and the interior basin drained to approximately low tide level.

In order to have a source of power available during the period when the power house is shut down, a large pumping plant and generating station is being erected near Haycock Harbor about 15 miles distant. Surplus peak power will be transmitted to the large pumping plant which will pump sea water into a large reservoir about 125 ft. above sea level. The water from this reservoir will be used by the auxiliary power plant to generate power when the main plant is shut down.





Architectural sketches of two of the single-family dwellings being erected for the workers on the Passamaquoddy Dam.

the use of extensive timber piling with concrete mats. The boiler house is served by a railroad siding, enabling the delivery of oil by tank car. Storage facilities consist of two 20,000-gal. steel tanks adjacent to the structure, and served with steam coils to facilitate oil pumping.

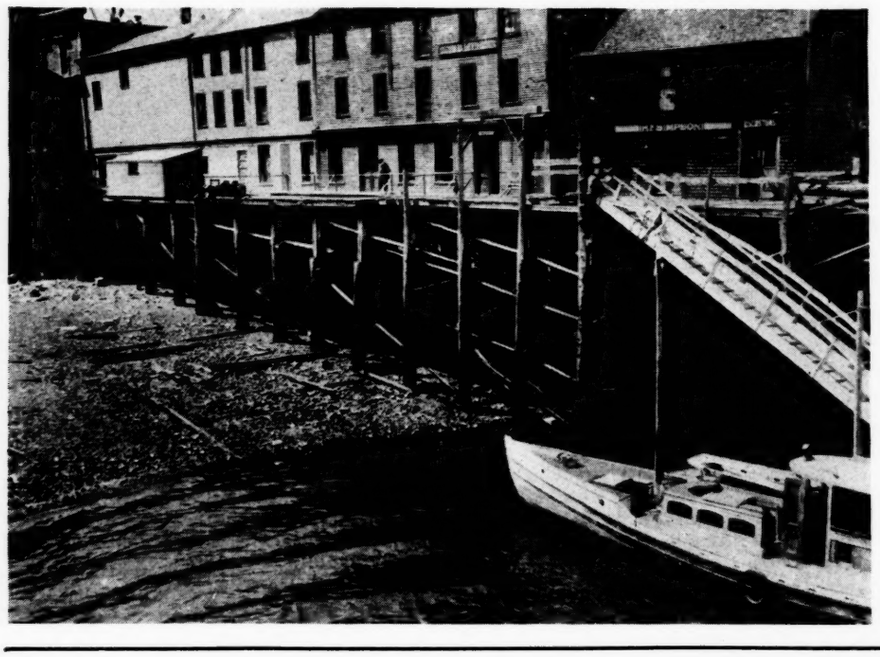
Steam Distribution System

The underground distribution system, as before mentioned, consists of a network of underground steam conduit, in general sharing a common trench with water and sewerage facilities. More than three miles of such conduit have been installed, necessitating the use of some 40 carloads of conduit material alone. The conduit finally selected as being the most adaptable to the type of work was of the type requiring filler insulation. The several units of the conduit are first, a vitreous clay base drain which supports the conduit itself, also of vitreous clay, and finally, pipe supports which extend into the conduit, and rest on adjoining sections of base drain. Base drain and conduit sections are in 2-ft. lengths, joints of conduit occurring at the center of each base drain, thus insuring a more substantial structure. The separable conduit halves are provided with lips which tend to key the mortar joints into position and shield them from damage. A waterproofed asbestos fiber insulating material is loosely packed into the conduit, surrounding the steam piping to a density predetermined to give maximum insulating efficiency. The whole conduit is protected from intruding groundwater by means of the open-joint base drain and its surrounding granular fill, composed of stone or gravel. At intervals, the subdrain is drained into the parallel sewer system. The necessary expansion joints, valves, traps, anchorages, etc., as well as changes in line and grade, are housed in manholes.

Laid out to fit the topography to best advantage, it is possible to return the majority of the condensate by gravity. The system is, therefore, a two-pipe system, ranging in size from 8-in. supply and 4-in. return, to 1¼-in. supply and 1¼-in. return. The corresponding conduit diameters range from 20 in. to 8 in. Pipes and fittings over 2 in. are welded, while the smaller sizes have screwed connections. A third pipe, ¾ in. in diameter, carries compressed air, as the operation of the controls is accomplished by pneumatic pressure actuated by a thermostat control.

Service Connections to Buildings

Service connections from the main line to the buildings are handled in three different ways. The usual manner is by means of standard connections made in manholes and running in a straight line to an access pit at the house. Expansion in all house lines is permitted by a swinging nipple flexible connection. A second method permits of connections in a blind pit, between expansion joints, the lateral movement transmitted to the service from the main line movement being taken care of by using a conduit slightly larger in size than otherwise necessary. In such cases, the return line, subject to less range in movement, is kept on the anchored side of the house supply service. A third



Low tide at Quoddy Dam site. Some idea of the difference of tide and power can be had from photo which shows low tide at government wharf, Eastport, Me. At high tide the water would reach the 27 ft. wharf. Photo by Keystone View.

Workmen digging the trenches in Quoddy Village for water, steam, and sewage pipes that will take care of the 120 homes now being erected. Photo by Wide World.

method is made possible by the use of a specially formed vitreous clay "T" fitting which can be used instead of a regular conduit section. As in the case of blind pits, the lateral motion transmitted to the house service is permitted by using a slightly larger size of house service conduit.

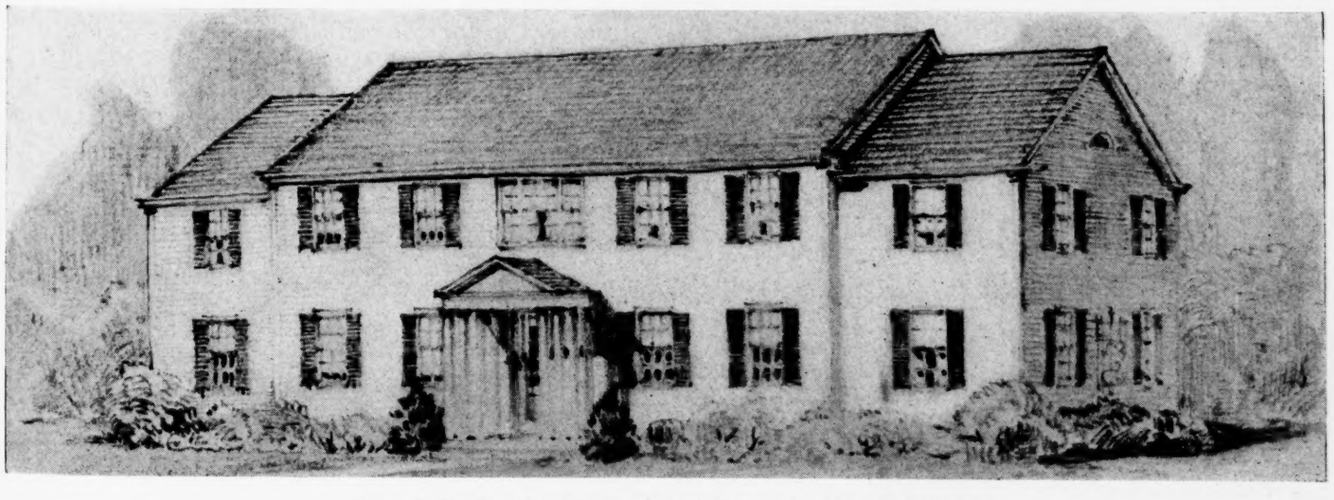
Domestic Hot Water

Not only is steam used to heat the houses, it is also utilized in providing for domestic use a constant supply of hot water at a predetermined temperature, which can be varied between 100° and 160° depending on the setting of the pneumatically controlled thermostat. Heating of the houses is accomplished by regulation of the steam supply to radiators by means of a "two-setting" pneumatic thermostat. It is thus possible to keep the house at a comfortable uniform temperature during the day, and, by using the second thermostat setting, drop the night-time temperature to a predetermined lower level. Regulation to within 1° of desired temperature is possible. By means of pressure reducing valves the initial pressure of 50 lb. at the main leaving the boiler house is reduced to a pressure of 1 lb. in the house system. The air pressure is maintained at 15 lb. for the pneumatic operation of the thermostatic controls.

Notwithstanding the great range of temperatures against which the system is designed to operate, and the contrasting geologic conditions encountered during construction, construction is proceeding at a satisfactory pace, and the system, in part, is already in successful operation. As fast as a group of buildings is finished and their steam supply mains and service are in place, the group is isolated from the rest of the construction by valves, a temporary boiler and feedwater receiver and accessories are set up, steam turned on, and many of the Quoddy staff move into the first home they have known since arriving in Eastport.

With the Quoddy Project approved on June 28, 1935, architectural plans for the village were completed in late August. Work was begun on the housing and utilities in September and on January 1 the housing project was 85% complete and the greater portion of the buildings were occupied.

The construction of this modern village is under the direction of the Corps of Engineers of the War Department with Lt. Col. Philip B. Fleming as district engineer. Capt. Royal B. Lord, head of the Operations Division of the Eastport District, is in direct charge of all construction and design activities, with Robert C. Blair and A. C. Bruce as assistants. Consulting engineer on the heating system was the A. B. Fels Co., Portland, Me. The architects for the buildings were John P. Thomas, John C. Stevens, and John H. Stevens, Portland, Me.



One of the four-family apartment houses in Quoddy Village.

What Does it Cost to Operate an Industrial Exhaust System?

By B. F. POSTMAN

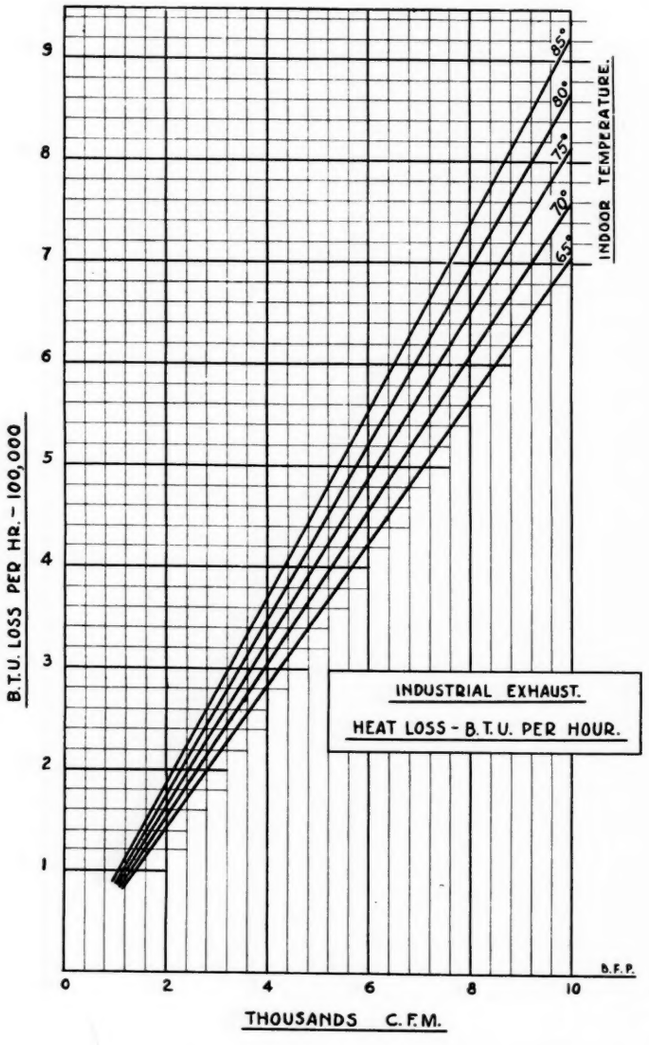


Fig. 1. Heat loss caused by exhausting air from an industrial plant.

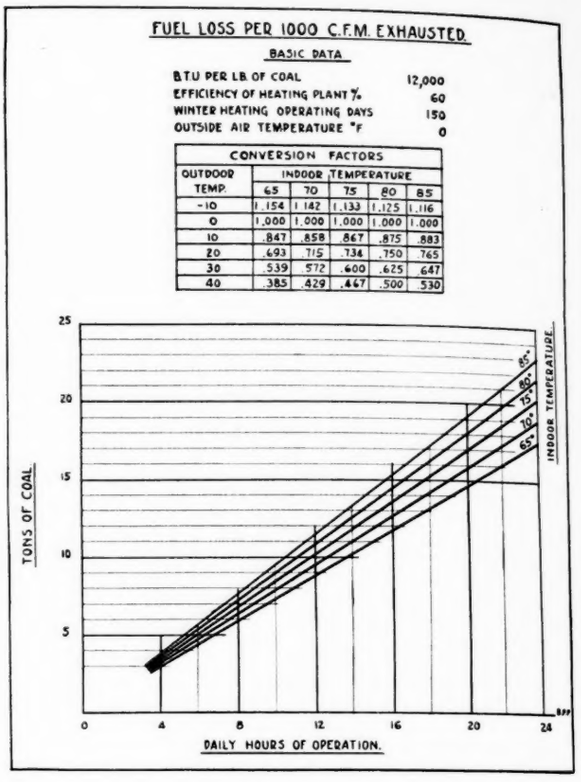

FUEL LOSS PER 1000 C.F.M. EXHAUSTED
BASIC DATA
B.T.U. PER LB. OF COAL 12,000
EFFICIENCY OF HEATING PLANT % 60
WINTER HEATING OPERATING DAYS 150
OUTSIDE AIR TEMPERATURE °F 0
CONVERSION FACTORS
OUTDOOR TEMP. | INDOOR TEMPERATURE 65 | 70 | 75 | 80 | 85
-10 | 1.154 | 1.142 | 1.133 | 1.125 | 1.116
0 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000
10 | .847 | .858 | .867 | .875 | .883
20 | .693 | .715 | .734 | .750 | .765
30 | .539 | .572 | .600 | .625 | .647
40 | .385 | .429 | .467 | .500 | .530
TONS OF COAL
DAILY HOURS OF OPERATION.
INDOOR TEMPERATURE
85°
80°
75°
70°
65°
B.F.P.

Fig. 2. Coal consumed in heating air exhausted from an industrial plant.

THERE is no disguising the fact that it does cost money to operate an industrial exhaust system, not only from the standpoint of power necessary to drive the fan, but more particularly due to the heat which is removed from the building by the exhaust system during the winter.

As a help to the heating engineer in figuring the necessary additional radiation required to offset the heat lost through exhaust systems, the curves in Fig. 1 have been prepared. It has been found that the maximum amount of exhaust shown, 10,000 c.f.m., or multiples of that figure will fit practically all industrial practice.

The curves in Fig. 2 show the fuel loss per 1,000 c.f.m. of air exhausted and are a continuation of the curves in Fig. 1 in that the heat losses of Fig. 1 are expressed in tons of coal in accordance with the data shown in Fig. 2. Due to the fact that some definite data had to be used to make these curves, there has been added a table of conversion factors to take care of the different average outdoor temperatures.

Fig. 3 shows the operating costs of motors per horsepower at different kw-hr. rates. The time periods may be explained as follows:

(a) 100 days—approximately summer refrigeration operating period.

(b) 150 days—approximately winter heating operating period.

(c) 260 days—5-day-a-week plant operation, under which many plants are operating today.

(d) 300 days—old time period of plant operation.

(e) 365 days—continuous operation.

These curves will enable one thoroughly to investi-

gate the operating cost of any exhaust system. Having the first cost of an installation, plus the yearly maintenance and repairs, by adding the cost of operation covering electrical and heat energy, a complete picture is to be had of a problem which normally is allowed to be ignored, but which continually adds to plant operating cost.

Example

To find the yearly cost of operating an exhaust system which is removing 8,000 c.f.m. at 65°. The plant operates 8 hr. a day; winter heating period is 150 days; yearly plant operating period is 260 days. A 5-hp. motor drives the fan. Cost of electricity 1½c. per kw-hr.; cost of coal $3.50 per ton. Average winter temperature 20°.

From Fig. 1 the total heat loss is 582,000 B.t.u. per hr.

From Fig. 2, the tons of coal used per year in heating each 1,000 c.f.m. of air exhausted is 5.85, so that the total coal consumption for 8,000 c.f.m. is

$5.85 \times 8 = 46.8$ tons, when the outside air is 0°.

Since the average winter temperature is 20° and inside temperature 65°, the total coal consumption is multiplied by the factor 0.693, obtained from the table in Fig. 2. The coal used in heating the exhaust air then becomes

$$46.8 \times 0.693 = 32.4 \text{ tons}$$

As electrical energy costs 1½c. per kw-hr., the cost of driving the fan is found from Fig. 3 to be $13.50 per hp. This is for 1 hp. at full load. Although the variation in load, motor efficiency, and plant power factor enter into the picture, these factors are so variable that it would be almost impossible to plot them correctly. Since a 5-hp. motor is driving the fan, the electrical cost would be

$$5 \times \$13.50 = \$67.50$$

The cost of the coal would be

$$32.4 \text{ tons at } \$3.50 \text{ a ton} = \$113.40$$

Total cost per heating season is thus $67.50 plus $113.40 = $180.90.

The electrical cost of operating the exhaust system during the summer can be found from Fig. 3 by determining the cost of operating the fan for 260 days and subtracting from this the winter operating cost. The cost for 260 days is $23.50 per hp. For 150 days it is $13.50. The difference which is the summer operating cost is $10 per hp. For 5 hp. the cost is $50. Thus the total yearly cost of operating the exhaust system is $180.90 plus $50 or $230.90.

In some plants a mistake is made in installing the exhaust fan where it will exhaust the warmest air from the building. This is good practice during the summer but in the winter it is extremely wasteful. This is shown in the following example.

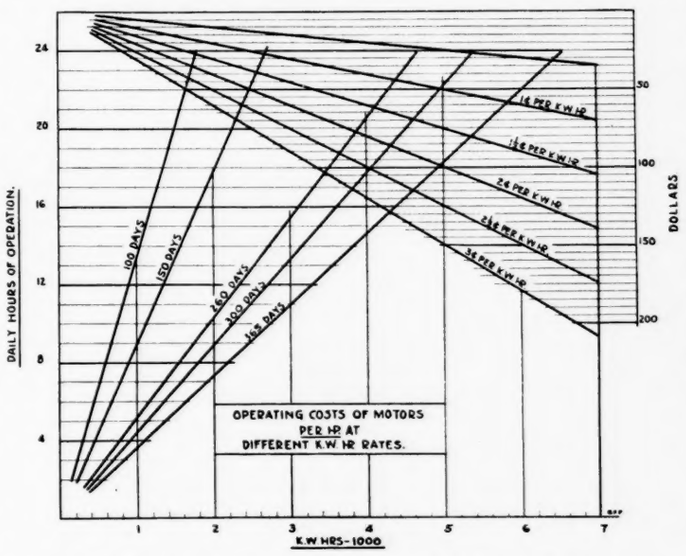


Fig. 3. Cost of operating a motor driving an exhaust fan over various periods.

Example

Suppose that the system outlined in the previous example is installed so that instead of removing 65° air it exhausts 80° air. How much will the coal consumption be increased?

From Fig. 2, with the inside air at 80° and the outside air at 0° the coal used per heating season of 150 days is found to be 7.25 tons per 1,000 c.f.m. of air exhausted. For 8,000 c.f.m. the coal consumption will be $8 \times 7.25 = 58$ tons. Since the average winter temperature is 20° the corrective factor 0.750 obtained from the table in Fig. 2 will have to be applied.

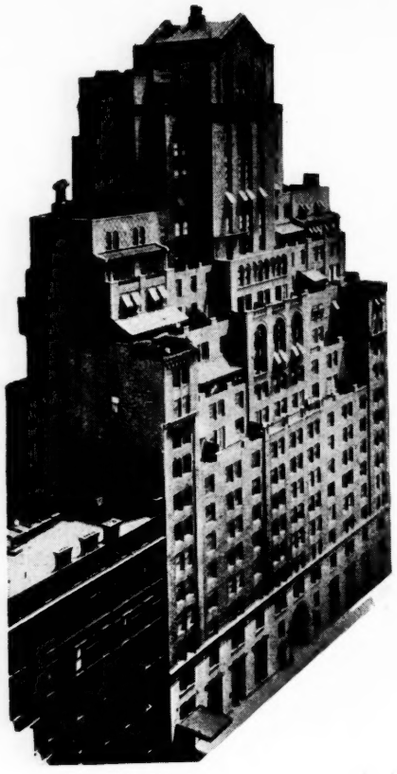
$58 \times 0.750 = 43.50$ tons of coal for the heating season.

The coal consumption when 65° air is exhausted was found to be 32.4 tons in the first example. Thus the increase in coal consumption is 11.1 tons, an increase of 34.2%.

Other Uses for Curves

These curves can also be used in another manner. Suppose that due to some industrial operation, there is an excessive amount of heated air being exhausted, air which perhaps needs only be filtered or cooled somewhat by an admixture of outside air, so that it could be used in a distributive duct system for general plant heating. The use of these curves will enable one to determine just how much money is being thrown away in exhausing the warm air instead of using it for heating. This saving can then be deducted from the cost of a duct system and heat transfer surface needed for producing this heat and the final figure balanced against the cost of a unit heater installation and the additional steam requirements of such a system.

Then again there is the possibility, in the case of a woodworking or grinding wheel exhaust, of passing the air through a regular metal or cloth screen dust collector or a combination of both, depending on conditions, where all of the foreign material is definitely removed. This air is then picked up by a fan and discharged through a duct system in the plant for heating or ventilation. If used for heating, some additional heating coils would be necessary, as there would be a decided heat loss from the exhausted air. Much can be done along the lines of economic investigation to help offset the losses annually occurring in exhausting air during the heating season from industrial establishments.



Automatic Control Eliminates Heating Troubles in Large Hotel

OF unusual interest to heating engineers and building managers are the changes made recently in the heating system of the Hotel Lombardy. These changes have resulted in a considerable improvement in the operation of the system while the steam consumption has been reduced.

The Hotel Lombardy is a large residential hotel located at 109-11 East 56 St., New York, N. Y. The building is on the north side of the street and is approximately 250 ft. high, having 23 floors and two basements. Above the 12th floor, the building is terraced every two floors. The cubic content is approximately 2,040,000 cu. ft. and the heated volume about 1,900,000 cu. ft.

District steam is used in the heating system. It is brought into the building at approximately 125 lb. in two mains, one for hot water and cooking and one for heating. Steam for heating passes through two reducing valves in series and enters the steam main at 2 lb. per sq. in. Steam for hot water and cooking is similarly reduced to 15 lb.

The main steam line, 12 in. in diameter, runs up to a pipe gallery between the 14th and 15th floors where it splits into two 8-in. mains—one for the north heating zone and one for the south. Steam is fed both up and down from these mains to 649 radiators. There are 29,980 sq. ft. of radiator surface in the building with 14,820 sq. ft. in the south zone and 15,160 in the north. Approximately 80% of all the radiators are enclosed.

The condensate leaves the radiators through steam traps, flows through the return mains and into a vacuum pump. From the pump it passes through hot water pre-heaters and is then wasted to the sewer.

Control of Old System

The amount of steam flowing into the heating system was formerly controlled by a timing switch which turned the steam on and off at predetermined time intervals, which had to be changed to meet changes in weather conditions. Constant expansion and contraction of the pipes caused the expansion joints in the long risers to leak. Unless a careful watch was kept on the weather conditions and the control set accordingly the building became over or underheated.

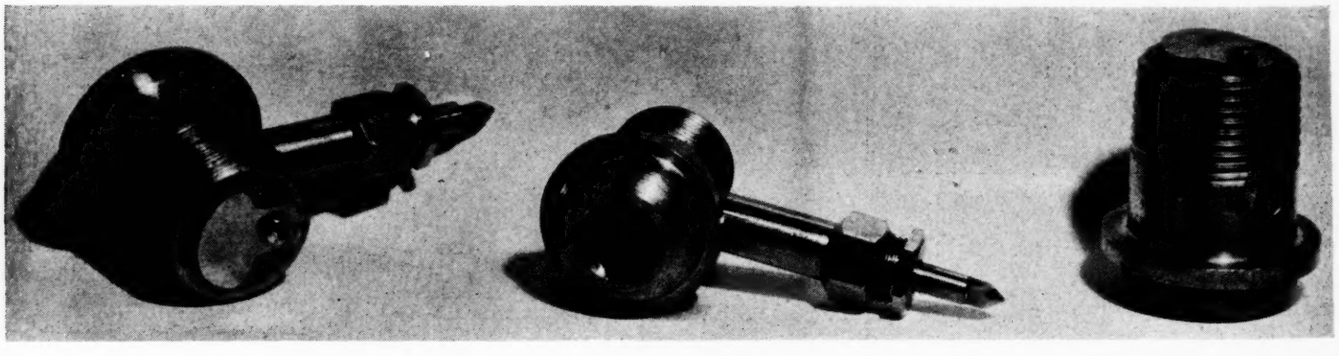


Fig. 1. Three types of proportioning graduators which were installed in the branch feed connections to each radiator in the Hotel Lombardy.

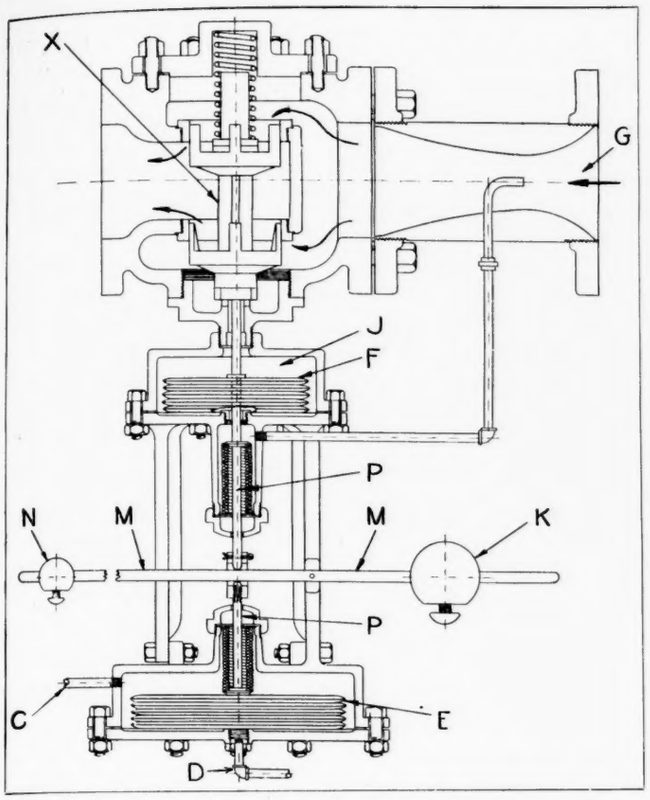


Fig. 2. Weather controlled zone valve. Two of these valves were installed—one in each zone main.

Some use was made of the manually operated valves on the main north and south zone lines in the pipe gallery for controlling the steam flow. However, since these were located in a rather inaccessible place there was considerable likelihood of the employes neglecting to change their settings.

From the foregoing it can be seen that a control which would automatically regulate the amount of steam entering each zone according to the outside weather conditions would eliminate constant manual valve adjustment. Moreover a type of control which would proportion the amount of steam instead of shutting it off completely and then turning it on full when the building needed heat would minimize expansion and contraction of the piping. The comparatively new Sarco Graduator system was selected as being adapted to meet these requirements.

Changes

In modernizing the system a zone control valve was installed in each of the zone mains. This was done by welding a bypass line around each old manually operated zone valve. The new zone control valves were installed in this bypass line, hand shut-off valves being placed on each side of the control valves. To improve the steam distribution in the system an automatic graduator valve was installed at the inlet connection of each radiator. Two indoor and two outdoor thermostats, one set for each zone, were also installed. The north zone outdoor thermostat was supported on an outside wall above the 12th floor terrace in the northeast corner of the building. The north zone indoor thermostat was placed in a northeast room on the second floor. The south zone thermostats were placed on the same floors as the north zone thermostats but were located on the southwest side of the building.

One other change was made. In the old system the south zone steam main fed a large portion of the steam radiators and risers in the northeast corner of the building. This resulted in these radiators receiving insufficient steam when the valve was adjusted to send the correct amount of heat to the south side of the building. To feed these radiators from the north zone supply system a new branch line was welded in connecting the north main with the risers supplying these radiators. A shut-off valve in the pipe connecting the risers with the south main was then closed.

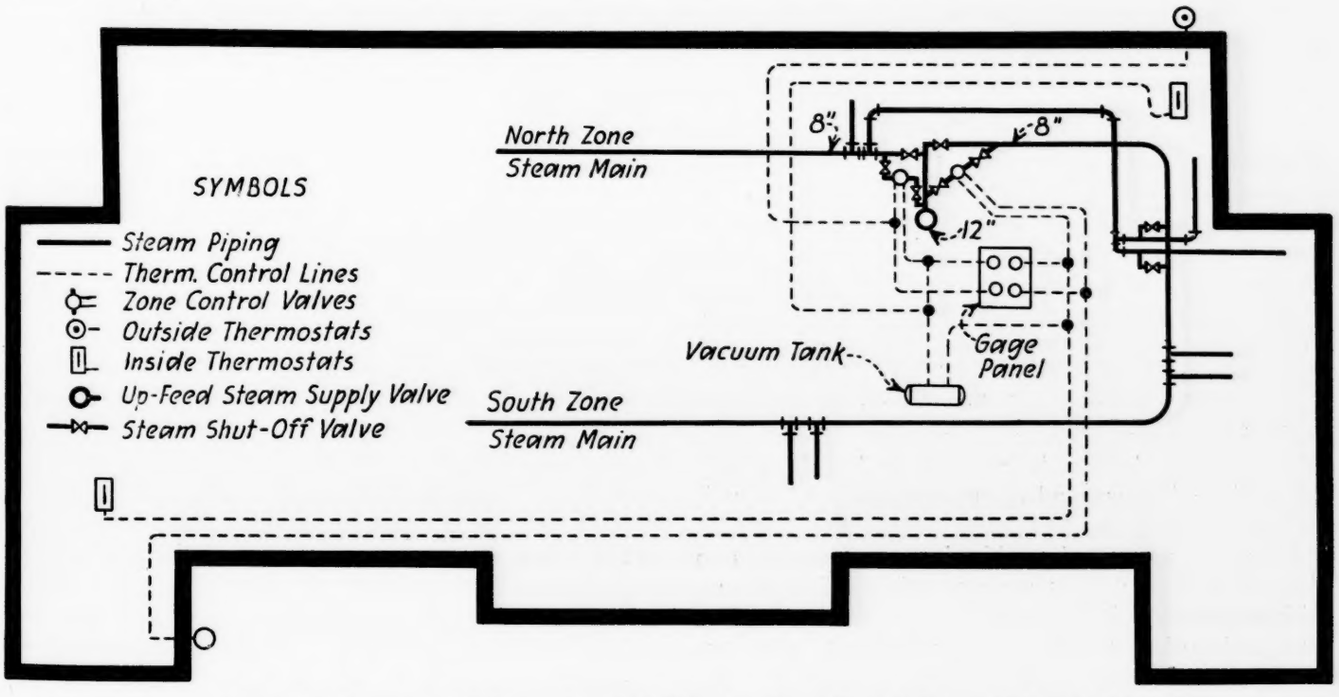


Fig. 3. Schematic diagram of piping and control lines in pipe gallery between 14th and 15th floors.

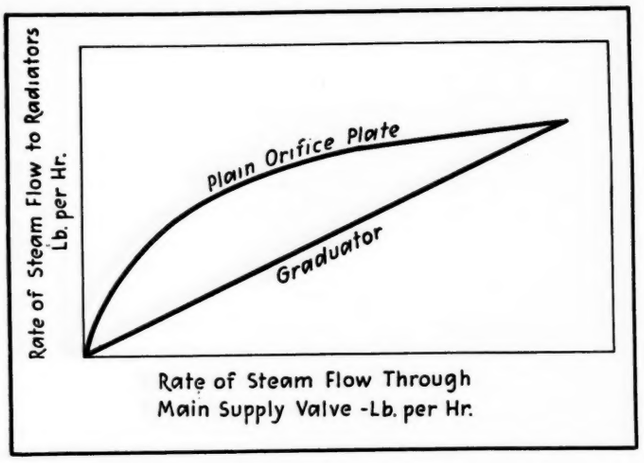

Rate of Steam Flow to Radiators Lb. per Hr.
Plain Orifice Plate
Graduator
Rate of Steam Flow Through Main Supply Valve -Lb. per Hr.

Fig. 4. Comparison of steam flow through a graduator and a plain orifice plate in a controlled heating system.

Operation of the New System

The operation of the system up to the point where the main 12-in. steam pipe is divided into two 8-in. mains is just the same as in the old system. But here the steam instead of flowing through the time operated valve passes through the new zone control valves.

In operation the zone valve is controlled directly by the outside conditions—air temperature, solar radiation, and wind velocity. The amount of steam flowing through the valve, shown in Fig. 2, is controlled by the balancing of the pressures in the two bellows *E* and *F*. The valve piston *X* is moved by the stem *P* which is connected to the bellows *E* and *F*. Thus the position of the valve piston depends on the combined pressure effect of the two bellows.

The pressure in the smaller bellows *F* is caused by steam entering the valve through the venturi throat *G*. The area of this throat is designed to create a predetermined steam velocity when the heating system is taking its maximum demand in the most severe weather. This steam velocity exerts a dynamic pressure in the pitot tube *H* which transmits this pressure to the bellows *F*. The static pressure of the steam beyond the throat is conveyed through a passage in the valve to the chamber *J* surrounding the bellows *F*. Hence this is actuated by the net flow head or velocity pressure of the steam passing through venturi *G* and its operation is independent of the initial steam pressure and final pressure in the heating system. Thus the pressure due to the velocity of the steam acting on the bellows *F* helps to support the weight of the valve mechanism.

The large bellows *E* receives its pressure through tube *D* from the thermostat on the outside wall of the building. This thermostat is in reality a closed copper tank of approximately 3 cu. ft. capacity. It is connected to the valve bellows by means of a 3/16-in. copper tube. Tube, bellows, and thermostat tank are hermetically sealed.

Enough air is added to this thermostatic system so that when the outside temperature is 0° the pressure within the system is just equal to the atmospheric pressure. When the outside temperature rises, the pressure within the tank increases and forces the bellows *E* upward tending to close the zone valve. The closing of the valve, however, reduces the amount of steam flowing through the valve which in turn reduces the pressure in the smaller bellows *F*. This causes the valve to open again slightly until the forces exerted by the two bellows and the weight of the valve piston are again in equilibrium.

Preventing Overheating

In case the outside temperature increases so rapidly that there is danger of overheating the rooms, the indoor thermostat comes into operation. This thermostat is connected to the chamber of the larger bellows *E* by the copper tube *C* and is also connected by another tube to the vacuum return of the heating system. Normally, when the room is at or below the proper temperature, a valve in the thermostat is open so that atmospheric pressure exists in the chamber surrounding the large bellows *E*. Whenever the room temperature rises above the temperature for which the thermostat is set, the valve in the thermostat closes. This causes a vacuum to form outside of the bellows, expanding it fully, lifting the valve piston and closing the valve. As soon as the temperature in the room returns to normal, the valve in the thermostat opens and the zone control valve is again controlled by the outside temperature.

The weights *K* and *N* on the arm *M* are provided for adjusting the operation of the valve to suit the individual requirements of any given system.

Graduator Valves

After the steam leaves the zone control valve, it flows through the zone main to the risers and thence to the individual radiator branches. A special fitting, known

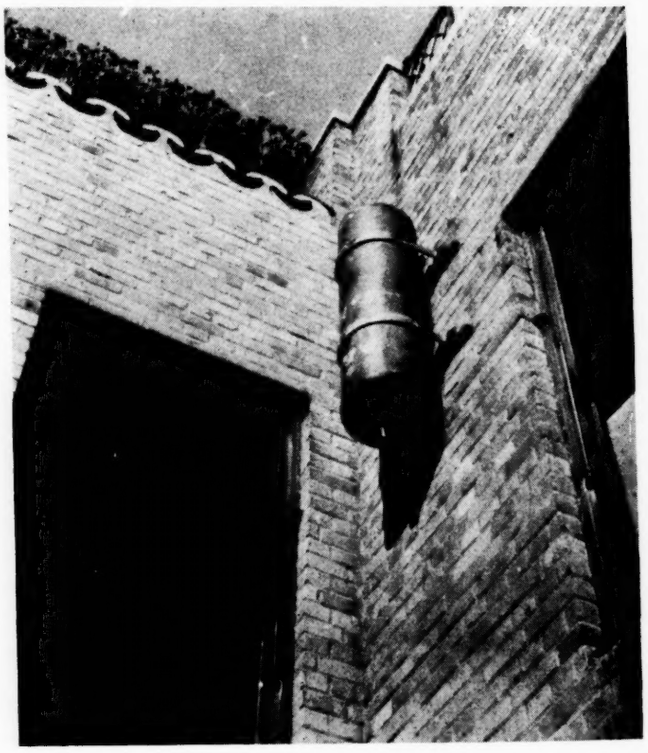


Fig. 5. Outside thermostat as installed above the 12th floor terrace in the southwest corner of the building.

as a proportioning graduator, has been installed in the branch feed connection of each radiator in order to insure equal distribution of the steam to all parts of the system, even when very small amounts of steam are being passed by the control valve. This graduator differs from the usual disc, or metering orifice placed in radiator valves, in that it tends to proportion the flow of steam to each radiator directly according to the velocity of the steam in the mains. With the usual orifices, as the steam pressure increases the rate of increase of steam flow becomes less. In other words, when the steam pressure is low, a slight increase in pressure will result in a large increase in the amount of steam flowing through the usual orifice, but when the steam pressure is high an equal increase in pressure will result in only a small increase in flow.

The graduators used at the Hotel Lombardy take the place of the usual radiator valve spuds and serve as the connecting pieces between the radiator bushings and the shut-off valves. They are practically the same shape as an ordinary radiator nipple, but have a relatively smaller bore. A flexible nichrome spring steel plate is mounted transversely to the bore of the graduator and at a fixed distance from the back surface of the same. This distance determines the amount of steam admitted to the radiator at a minimum steam velocity. When the steam velocity in the branch main increases, the spring plate bends outward so that the amount of steam flowing through the graduator, and entering the radiator, increases by virtue of a larger free opening as well as a higher velocity. The net result is a uniform increase in the amount of steam received by each of the individual radiators in direct proportion to the increased flow through the main, or zone control valve.

The graduators used on the majority of radiators in the Hotel Lombardy are provided with extended stem adjustment screws, which permit external regulation of the size of the steam passageways in the graduator without breaking any piping connections. Ordinarily, however, graduators are made up in a form somewhat similar to that of the cup type orifice, and are insertable in radiator valve union connections, in the usual manner. The use of externally adjustable graduators, in this instance, was made necessary by the extreme inaccessibility of the radiator connections, most of which are buried beneath flush type radiator inclosures. Naturally, it would be highly impractical to tear apart these inclosures a second time should adjustment of one kind or another be required.

Indicating Board

In the stairwell just outside the pipe gallery is an indicating board showing the operation of the system and instruments are provided to show the average outdoor temperature affecting each side of the building.

Some Summer Air Conditioning Costs

SOME cost data and other figures on air conditioning were part of a talk given by A. C. Buensod, president of Buensod-Stacey Air Conditioning, Inc., before the December meeting of the Air Conditioning Bureau of Boston. A summary of some of his figures follows:

For a fairly large office building, the total cost per year for complete conditioning ranges between $1.30 to a little above $2 per sq. ft., according to the height, shape, and layout. Buildings with alcoves, and turns tend toward the higher figures. The average is about $1.45 for a complete installation.

Operating costs are more difficult to figure. Electric power, water, manpower, and supplies average from 8 to 10 cents per sq. ft. in the New York-New England territory. The figure would be considerably higher in the south, where more refrigeration would be required. Capital charges and depreciation at an average of 11% of the investment would add 17 to 22 cents per sq. ft., making the total operating cost 25 to 30 cents per sq. ft. in the New York-New England area with from 1,200-1,800 hr. of winter operation, covering humidification, heating and washing or filtering.

Exposure affects operating costs. When this happens the conditioning must be zoned. In Philadelphia, the Philadelphia Savings Fund building, a very high structure, has one whole side practically of glass. Here it was found that the worst load was on the east side, in the morning. The Filene store in Boston had a total cost of $1.31 per sq. ft. The estimated operating cost for this store is 9½ cents per sq. ft. With carrying charges, etc., at 11%, equivalent to 14½ cents per sq. ft., total operating cost would be 24 cents per ft. per year.

In the Kresge store in New York the cost of installation approximated $2.80 per sq. ft. with 90 cents for operation. One reason for this high figure is that the store has 12 watts of lighting per sq. ft., resulting in a very large heat load, while Filene's has about 6 watts per sq. ft., although well lighted. The Kresge store has twice the live load, also, with 1,500 people at a time in less space.

One apartment house air conditioning job cost $2.30 per sq. ft. to install, when the expectation was a much higher rate. Each apartment has its own recirculating system. Here the total operating cost is 50 cents per sq. ft., bringing the total cost per square foot to 86 cents, with 24-hr. use. In summer 24-hr. operation is absolutely necessary.

Stoker Installation Saves $5,000 Annually

WHEN the owners of the Ansonia building, an industrial structure in Brooklyn, N. Y., decided to modernize their heating plant they had little idea that the savings effected by use of two stokers would be nearly as important as proved to be true. This 50-year-old, four-story brick manufacturing building occupies nearly an entire city block. Like many old buildings of this type heating was by wall-located pipe coils and this is the present method. Among the 30 tenants that occupy manufacturing quarters are a rubber sheeting mill, several cleaning and dyeing concerns, a manufacturer of dog foods, and other businesses that require large quantities of steam and hot water for processing.

Ansonia Building, Brooklyn, N. Y., modernized with two 7½-hp. stokers

The boilers, now 27 years old, are 175-hp. horizontal tubular type, with full brick setting. Formerly, slack coal was burned and this required the full time of an engineer, assistant engineer, and a fireman. In spite of hard work by the boiler room crew, tenants complained frequently about deficiencies in steam and hot water supplies. Both boilers were operated all the time and consumed an average of eight tons daily. At 300 work-days per year and with fuel at $6 per ton the owners had a substantial fuel bill. Tenant complaints must have meant, had former conditions continued, that not alone could the landlord not increase rentals but he undoubtedly would have had vacancies. The constant, heavy load on the boilers must have resulted in substantial repair bills. Payroll for plant operation was high.

Following the installation of two screw type underfeed mechanical stokers by a stoker company during the summer of last year there was marked improvement almost at once. From an 8-ton daily fuel consumption, fuel requirement has been reduced to five. Although both boilers were stoker-equipped, but one now has to be run. Usage is alternated weekly so that cleaning and repairs can be made on idle boilers during shutdowns.

Fuel was changed from bituminous to buckwheat, relative per ton costs being about the same as before. The fireman was transferred to the maintenance staff that has to do with general building upkeep. Automatic control functions as pressurestat, stokers being started when steam pressure falls below 100 lb. Previously steam was furnished to all tenants for manufacturing purposes as well as heating as a part of the lease. As leases expire, however, the owners now are metering individual steam supply lines to tenants' quarters and steam is charged for as an extra. The assistant engineer fills the stoker hoppers, which duty requires only part of his time. Considering the decreased tonnage now used, contrasted with former tonnage required, deducting one man's time, extra revenue from metering steam, adding for electric power required for stoker motors, the owners' yearly net saving due to the modernization is estimated at $5,000.

Heating at Large Industrial Doors

FOR years the problem of heating economically and effectively the entrances to garages, bus terminal stations, freight houses, freight and passenger docks and piers, shipping and receiving departments in stores, factories, and warehouses, has been a constant objective as well as a worry to the heating engineers who have concentrated on the problem.

It is practically impossible to stop cold air from entering such large openings, for cold air will always enter when a door stands open—more when the wind is blowing and less when it is not. Therefore, the only economical and practical method left to overcome this condition is to warm the air that enters.

To accomplish this, one method is to install a high velocity unit heater suspended from the ceiling just inside of and directly over each door opening. The column of heated air forced directly into the path of the incoming air thus warms it to ensure the comfort of workers as well as customers. The air naturally continues to blow in but it is warm air and the motion that it has, forces it back to remote sections of the space.

The unit itself can consist of a combined electric and steam directional heater, adjustable to take care of minimum and maximum exposure—allowing the amount of heat to be reduced without affecting the air volume and velocity. It should also be adjustable to correspond with amount of steam available at the time.

An especially powerful fan driven by a small motor draws a large volume of air through a highly efficient copper coil and gives it high velocity, downward direction, and penetration.—*J. M. Hancock*

A Rock Storage Oven for Electrical Heat†

By H. J. DANA and R. E. LYLE

AT the rates prevailing in most localities, electricity for air heating has not been able to compete with coal or oil. When arguments are advanced for lower rates for heating based on larger units of consumption, the objection is made that lower rates are not justified because the peak of the heating load would be superimposed upon a badly peaked load and, therefore, might in some cases give rise to an even worse load factor than exists at present. If domestic heating could take power during the offpeak period, or if it could be controlled so that a high load factor could be maintained on the system, then some of the principal objections to domestic heating with electricity would have been met and a lower rate could be established for this type of load.

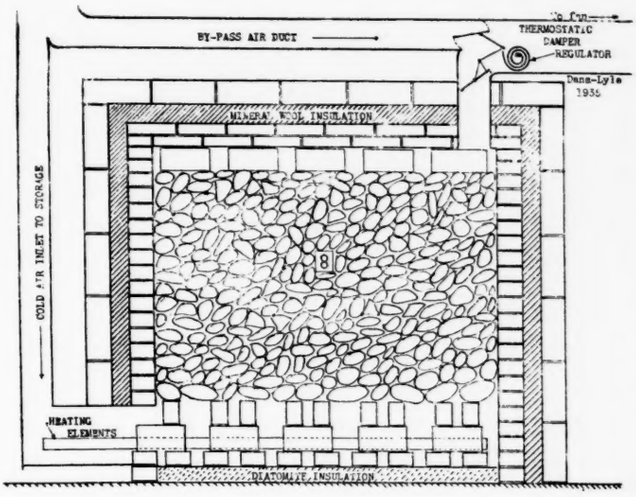


Fig. 1. Cross-section of experimental rock heat storage oven

Water suggests itself as being one of the ideal storage media and considerable data have been obtained on this type of heat storage. A well insulated water tank with proper heating elements will store heat in a form which can be controlled and readily distributed. Attached to a hot water radiator system and controlled by a thermostatic valve or by a circulating pump, thermostatically operated, heat can be delivered as required. The disadvantage of this system arises from the fact that water cannot be heated above boiling point unless a pressure vessel is provided and equipped with proper safety devices. Such necessary precautionary measures increase the cost of this type of storage and partly offset some of the advantages of using water.

Another type of heat storage consists of an insulated oven filled with brick or with rock. In a locality where rock is available such an oven can be constructed at moderate cost. The advantage of using brick or rock lies in the fact that either one can be heated to a relatively high temperature, say 500° to 600°, and therefore the space requirements for the storage unit need not exceed the space occupied by the ordinary domestic furnace.

When the decision was made to electrify Mason City, the contractor's camp at the Grand Coulee Dam Site in the State of Washington, opportunity was given to the State College of Washington to use it as a field laboratory and to carry on an extensive series of studies relating to the use of electricity for domestic heating. This laboratory, the largest of its kind in the world, consists of 286 residences and 61 bunk houses and dormitories, all heated 100% electrically.

One of the houses in Mason City was set up as a special laboratory for making tests of the feasibility of heat storage. A full basement, 20 ft. x 28 ft., was constructed under this house with walls and floor of concrete. A system of ducts and registers was laid out similar to that which would be employed in a warm air furnace installation in a residence of this type, and was connected to the heat storage device built in the basement. Forced air circulation was employed, the fan being thermostatically controlled from the living room.

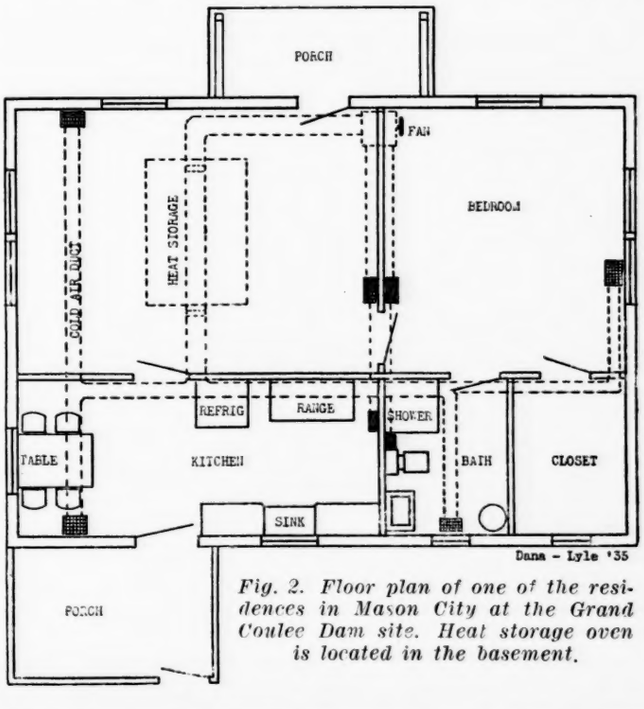


Fig. 2. Floor plan of one of the residences in Mason City at the Grand Coulee Dam site. Heat storage oven is located in the basement.

Heat Storage Oven

The plan followed in this investigation was to study the feasibility of a storage device which would be simple and cheap to construct from materials easily obtainable in any locality, and which would also be simple to operate. The first proposal was to build an insulated oven and fill it with

†Abstracted from "The Feasibility of Using a Heat Storage Device for Domestic Heating With Electricity," by Dana and Lyle, Engineering Bulletin 46 of the Engineering Experiment Station of the State College of Washington, Pullman, Wash.

brick checker work. However, this plan was abandoned in favor of using granite boulders, which were available within 50 ft. of the basement in which the storage oven was built. Basalt was considered, but the nearest supply was several miles away. All three have approximately the same value of specific heat, therefore, no preference was felt on this point.

In a device employing temperatures up to 500° or 600°, it is apparent that an inorganic insulating material must be employed. There are materials available for this type of service, among them being diatomaceous powder, asbestos, mineral wool, and rock wool. The heat conductivity for mineral wool ranges between 0.261 and 0.300 B.t.u. Since a supply of mineral wool was available, this was the type of insulation chosen for the experimental oven, and was packed lightly into the space between the inner and outer walls.

The oven as constructed consisted of a 4-in. interior wall of brick laid up with mortar. Outside of this wall and separated three inches from it was a 4-in. hollow tile wall with the space between the tile and brick wall filled with heat insulating material. On the floor of the oven was placed some two inches of diatomaceous earth in order to reduce the loss of heat into the concrete basement floor and from thence into the soil beneath. The diatomaceous earth in powder form was mixed with a small amount of Portland cement and water in order to make it solidify into a cake, and thereby prevent its being drawn up into the air duct system by the air drafts through the storage. The space inside the oven was then filled with boulders ranging from 3 lb. to 60 lb. in weight.

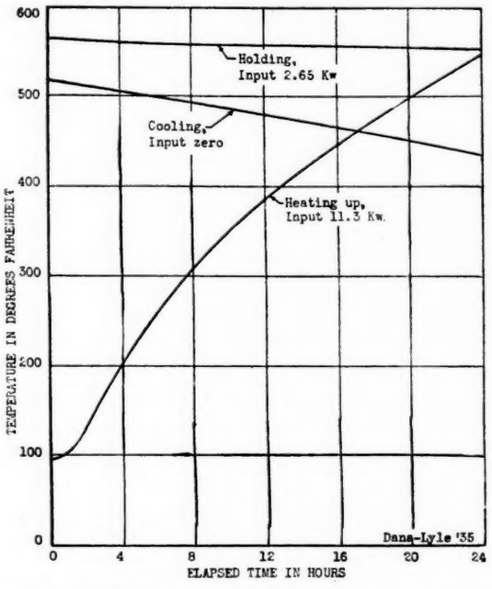


Fig. 3. Cooling and heating curves of experimental storage oven.

Size of the Storage Oven

The laboratory house in which the experimental storage oven was built was insulated on walls and ceiling with 3½ in. of mineral wool. It was estimated that the maximum daily heat required would not exceed one million B.t.u. for the coldest expected weather. Therefore, the storage oven was designed for a useful capacity of one million B.t.u. at 600° with an additional 690,000 B.t.u. available by raising the temperature to 900°. This would make it possible to carry the entire daytime heating load on the storage oven. On a practical basis, it might be desirable to carry only 4 to 6 hr. of the load on the storage oven. In that case, the size could be materially reduced.

Calculated Heat Storage Capacity of Oven

It may be assumed that all material inside the insulation jacket can be considered as the heat storage medium. The minimum effective temperature of operation was set at 170°, and the maximum for this calculation at 600°. Table 1 shows the quantities used in the oven and the data for calculating the heat storage capacity.

TABLE 1.

Weight	Material	Spec. Heat	Temp. Rise 170° to 600°	B.t.u. Stored
7,151 lb.	rock	0.20 B.t.u.	430°	614,986
4,314 lb.	brick	0.22 B.t.u.	430°	408,104
492 lb.	clay	0.19 B.t.u.	430°	40,196
11,957 lb.			Total....	1,063,286 B.t.u.

1,063,286 B.t.u. represent an equivalent electrical energy of 312 kw-hr. During the charging of this oven, and running over its storage period and draw down period, there would be certain radiation losses. If we assume these to be, say, 7% of the output of the oven, then the total input would need to be 335 kw-hr. If we assume a charging period of 10 hr., the input would be 33½ kw., if 15 hr., then the input would be 22 1/3 kw. The percentage loss by radiation in each case would depend upon the storage temperature and the schedule of the charging and discharging cycle.

Provision is made for inserting the electric heater elements through a duct underneath this mass of rock so that when the electricity is turned on, the natural air circulation will carry away the heat and communicate it to the rocks in the oven. This heating up may be done at any desired time of the 24-hr. day and ordinarily would be accomplished during the period when electricity is least needed for other purposes.

Air Duct System

The duct system to the rooms is attached to this oven so that part of the cold air coming from the rooms enters near the bottom at one end. The warm air duct is attached to the top at the opposite end. When the oven is fully charged, the temperature of the air inside would be 500° to 600°. Such a high temperature is obviously undesirable in the ducts or in the room above. Therefore, provision is made for a bypass duct around the oven through which most of the air from the rooms is circulated by the fan. Only enough air is drawn through the heat storage to bring the temperature of the air in the ducts to approximately 150°. This is accomplished by means of an automatic thermostatically controlled damper adjusted to admit only the proper amount of warm air from the oven, mixed with the air in the bypass to yield the desired temperature.

Tests on Storage Oven

A 5-kw. heater was set up temporarily to blow warm air through the storage for several days after it was built in order to dry it out. Then the 11½-kw. heater elements were installed and turned on. After several days further drying out, tests were made to determine the rate of heating up, and amount of loss by radiation. Fig. 3 shows the curves for this test. After the oven had been heated up to working temperature, the input to the heaters was adjusted to maintain this temperature uniformly. If the heaters are adjusted so that a stable temperature is maintained in the storage oven, then the input to the heater elements represents the heat loss by conduction and radiation. In the case of the experimental storage oven, it was found that the heat loss at 555° was 2.65 kw. Not all of this heat, however, can be charged as loss because if a basement is reasonably tight, any heat liberated into such a basement warms the basement ceiling and makes a warm living room floor.

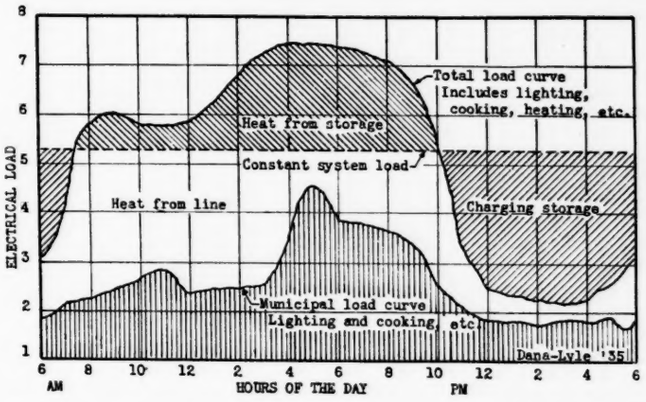


Fig. 4. Typical daily load curve for an eastern Washington municipality with an assumed heating load added to illustrate the advantage of heat storage.

These performance curves, as well as the calculations, reveal that the heating elements used are too small to fully charge the oven in 10 hr. Also, the "holding" curve and the "cooling" curve reveal that if heat is to be stored more than one day before being used, more insulation should be built into the oven.

Effectiveness of Storage Oven

In Fig. 4 is shown a 24-hr. load curve for an eastern Washington municipality in which some of the cooking is done by electricity, but no electrical heating is used. On this curve is superimposed an assumed heating load showing a new peak, approximately 85% above the present peak load. By clock control of a large number of heat storage ovens in a given district, the system load could be built up to an approximation of that shown in which the revenue producing load has been increased some 178% without increasing the demand on the system more than 20% above the peak.

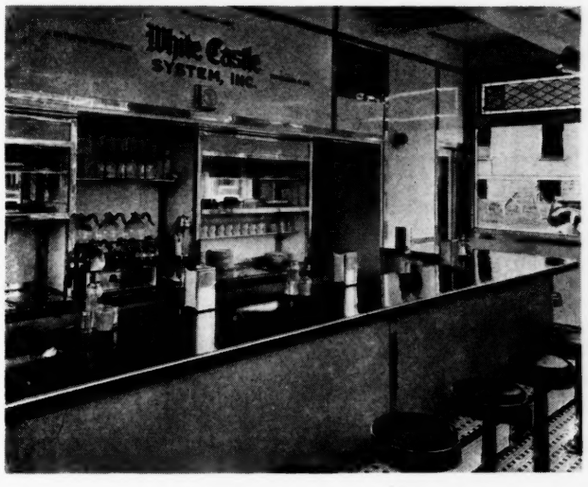
Hamburger Castles Heated with Gas

SOME 130 restaurant units of the White Castle System, Inc., in 13 cities, are now gas-heated. Most of the newer places incorporated this type of heat at the time of their erection, the remainder having modernized in this respect.

The standard method of arrangement is to have a self-contained gas-fired unit heater in a "work-room," adjacent to the lunchroom. The delivery face of the heater is then connected to a concealed sheet metal duct system leading to outlet registers placed along the baseboard of the counter. Of the several heat delivery methods tried, this arrangement appears preferable due to foot-warming of customers and the general theme of heat discharge near floor levels. Heating is automatically controlled by wall thermostat.

Behind the lunch counters are recirculation grilles, their ducts being suitably equipped with hand operated dampers so that fresh air, taken from outdoors, can be delivered through the overhead grilles in summer, thus reversing the air flow. It is the intention of the management of the White Castle System to install cooling coils in the higher ducts next summer so that cooled air will be delivered.

Although not here shown, the griddles on which the famous hamburger sandwiches are cooked (White Castle Menus offer nothing except hamburgers, coffee, and desserts) have separate exhaust fans connected to range hoods of conventional description.



Interior of one of White Castle buildings. Grille near the ceiling is for recirculation of air while grille at baseboard supplies heat.

Closely resembling the aforesaid restaurants there are several other units in and around Newark, N. J., known as Red Towers. These also are gas-heated, the method of duct arrangement, type and locations of grilles and unit heaters being much the same as already outlined.

Recently the White Castle System has started constructing these porcelain enamel steel buildings in their own factory in Columbus, Ohio.

A house, recently completed in Denver, whose outside walls are heated and cooled by sending conditioned air through ordinary building tile, placed end to end, before it is emitted into the rooms.

No Radiators or Registers, But Plenty of Heat

ALTHOUGH this Denver home has neither radiators nor warm air registers it has a plentiful supply of heat. The heat is supplied by a gas furnace and is distributed by a novel method developed by Lester L. Jones, a Denver architect.

The unusual feature of the installation is the use of the hollow space in the exterior walls for the distribution of the heated air. The air is discharged into the rooms through a narrow opening above the molding and on each windowsill. This feature serves two purposes—to eliminate all radiators and registers and a large amount of ductwork and to keep the exterior walls of the room warm so that heat is radiated from the walls to the occupants instead of from the occupants to the cold walls.

The first installation of the system was made in a six-room, one-story home of the colonial cottage type at East 26 Ave. and Hudson St., Denver.

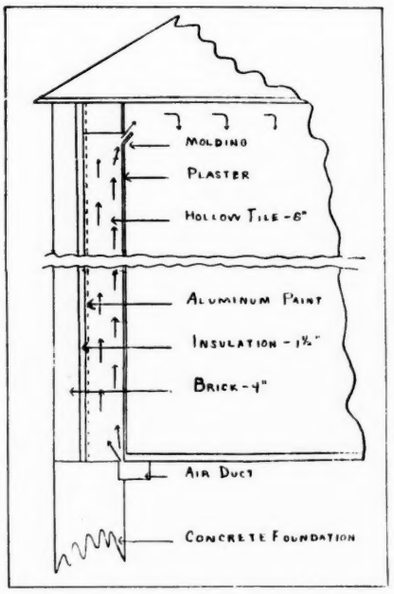
The outside walls, which rest on a solid concrete foundation, are constructed of 4-in. brick. Inside this is a 1½-in. layer of insulating material, in this case it is diatomaceous earth, then 6-in. of hollow tile finished with plaster.

The hollow tile, which is placed end to end, forms a continuous air duct around the house. Galvanized iron ducts from the heating and air cooling plant in the basement feed air into this encircling air duct.

The outlet for the air, which is completely hidden, is a ⅝-in. break in the tile above the molding on all the outside walls and a ⅝-in. opening in the ornamental tile on each windowsill. Thus the flow of air is introduced into each room from a long, concealed opening near the ceiling. It is returned to the basement plant through four return air ducts.

To supplement the insulating blanket in preventing escape of the heat through the walls, the inside surface of the outer edge of the building tile was sprayed with aluminum paint, to reflect the heat inwards.

The ventilating plant consists of a gas furnace and an air washer and blower. The latter not only cleans and humidifies the air but cools it by evaporation in summer due to the low relative humidity in Denver.



Cross-section of construction of outside walls. Small arrows indicate flow of air from basement duct through the molding.

Three warm air ducts lead from the furnace. They feed an arterial system which forms a continuous duct around the base of the outside walls, connecting with the opening in the tile. The ducts are tapered from the point where they first contact the wall to their end to equalize the pressure. Dampers in all subsidiary ducts offer further opportunity to balance the system.

Dampers on the ducts leading to the walls of the two bedrooms can be opened and shut by remote control from the rooms themselves. Registers in the ducts provide for heating the basement. Complete automatic control is provided by a humidistat, thermostat, blower starter, and limit control.

A test of the comparative cost of this system and an ordinary duct sys-

(Left) Looking up at openings of the hollow tile wall ducts in basement, where foundation and wall meet at the level of the basement ceiling. Ducts from the heating and ventilating plant are fitted to these openings. (Right) Looking down on one of the ornamental tile windowsills. Air flows into the room through the 1/2-in. opening from the tile air ducts in wall.

tem is in prospect through four houses which Mr. Jones has contracted to design in connection with a "model home" campaign launched this fall. One of the homes will have the ordinary system; three the new system. Conditions affecting ventilating will be identical in all four.

The wall heating system in these three houses will, however, be somewhat different in detail. The air will be circulated through a 3-in. space between the insulated brick wall and the plaster laths, instead of passing it through hollow tile, as was done in the first house.

Lemon Precooling Plant Maintains Constant Conditions

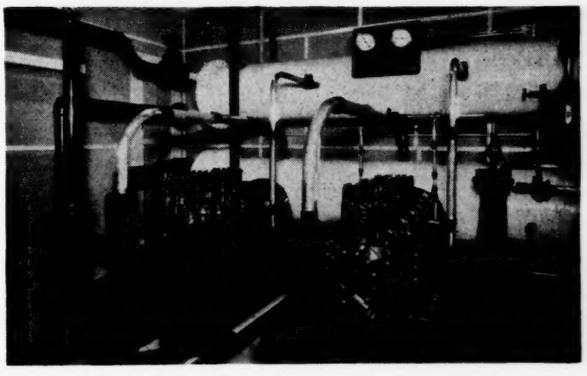
AN outstanding air conditioning installation, providing unusually close temperature and humidity control for fruit precooling has been installed at the LaVerne Lemon Growers Association, La Verna, Calif., by the Gay Engineering Corporation. Completely automatic, the plant is designed to maintain a constant temperature of 57° and a constant humidity of 90% for 100 cars lemon storage.

The equipment consists of two Westinghouse units connected to a common condenser and flooded type of evaporator. The plant is interlocked with a fan control and outside air damper so that some of the outside air can be used to maintain inside conditions. There are times when the outside temperature and humidity are such that it is not necessary to run the refrigerating equipment to obtain the desired inside results.

All of the equipment, including the outside air dampers, are completely automatic, being controlled by thermostats, humidistats, etc., to take advantage of natural climatic conditions and also maintain the desired predetermined inside temperature and relative humidity. Graphic temperature and humidity recorders show that constant conditions are maintained. The operating cost due to the design is exceptionally low, the maximum monthly power for the year being $62.99 for 7,790 kw.

For this particular application a special air conditioner was developed and termed the spray draft humidifying cooling unit. There are a number of these units suspended in various parts of the storage room, connected to a supply duct for air.

The water from the refrigeration plant is sprayed through the nozzle which controls the temperature of the air as well as humidity and also creates a natural air circulation through the spray draft units. During low wet bulb periods, it is not necessary to operate the fans for the circulation of air, inasmuch as the spray draft units set up their own air circulation.



Two condensing units for conditioning the air circulated through the air ducts. Note the mountings and vibration-free flexible connections.

Both compressor units are provided on spring supports and discharge and suction lines are provided with flexible tubing. The oil equalizer connection between the two compressors is also provided with flexible tubing so that the compressors can float freely on the spring supports. An oil separator, operating on the percolator principle, separates the oil from the liquid Freon in the evaporator.

Air Filter System for Plastic Molding Room

WHEN the General Electric Company installed a giant new press for forming large plastic moldings, it was faced with the problem of providing an absolutely clean working space. Cleanliness was essential, for the press was to be used for molding a radically new type of weighing scale case formed of a white plastic. If a single speck of dust got into the compound during loading it might possibly spoil the entire molding.

Special precautions were taken to prevent such an occurrence. The main press room and the finishing room were neatly painted and well lighted and provisions were made for scrubbing and flushing. To provide against the circulation of any dust or dirt in the air a special air filter system was designed for these two rooms.

The system provides an abundant supply of clean, filtered air, free from all traces of dust and other contamination in sufficient quantities to carry off the waste heat from the press. The air is drawn from the outside into a special filter room located in the basement under the press room. Here the air is filtered by passing it through a bank of glass wool filters. During the winter the air is also tempered in this room.

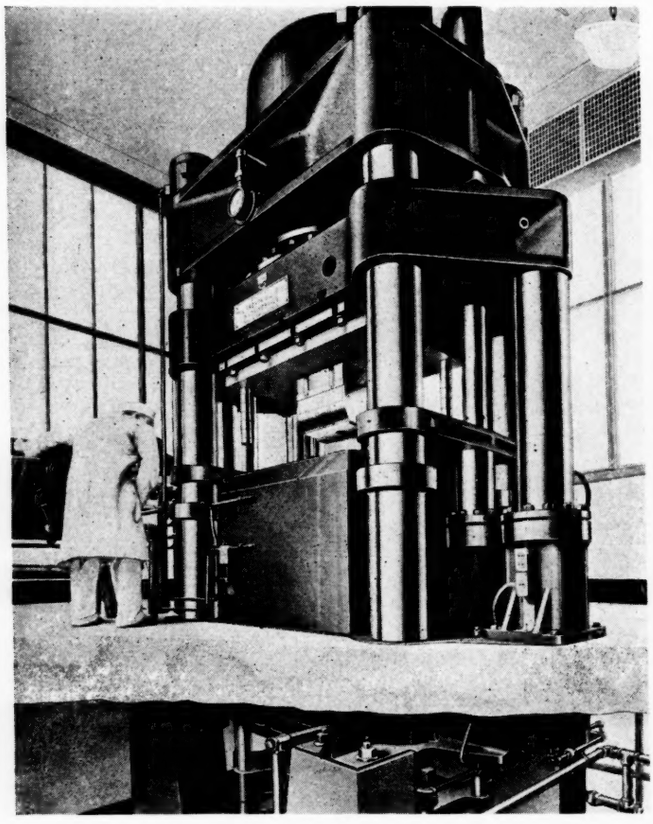
A fan then forces it up through ducts into the press and finishing rooms. A large opening in the air supply duct in the press room reduces the velocity of the air as it enters the room to a sufficient extent to eliminate turbulent air currents which might scatter the powdered molding compound. A similar arrangement of smaller capacity is also provided to insure a dust-free atmosphere in the compound storage room.

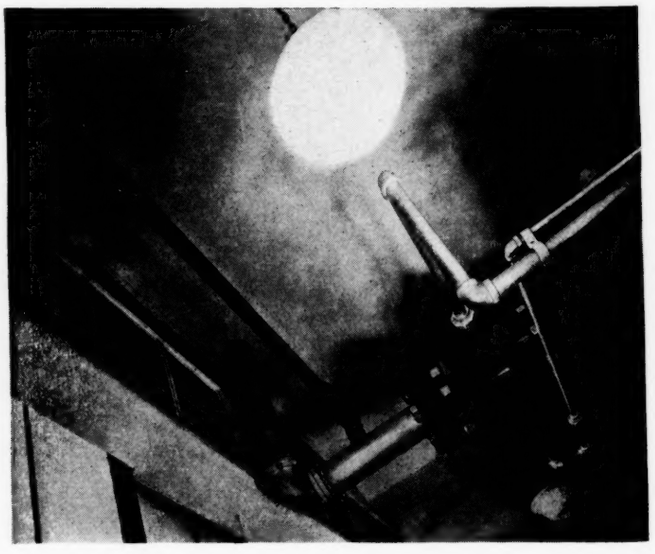
A maximum of one air change per minute can be secured in the press room if desired. The rate of air change is regulated by varying the speed of the 10-hp. variable speed motor which is used to drive the fan.

Some facts concerning the press and the molded scale case might prove of interest. The press is the largest plastic molding press in the world. It is 22 ft. high and weighs 89,000 lb. It has nine hydraulic cylinders operating at pressures of 1,500 and 3,000 lb. per sq. in. One cylinder operates the main pressing ram which is 36 in. in diameter and capable of exerting a force of 1,500 tons. The other cylinders operate rams used to provide the desired flexibility of performance needed in molding such large pieces as the scale case.

The mold used with the press to form the scale case is likewise of huge proportions. It weighs 7 tons. Its overall height, when closed, is 42 in. and its longest dimension, that of the stripper plate, is 60 in.

The scale case will be used to house a radically new type of weighing scale built by the Toledo Scale Company for retail merchants. When the scale was designed it was decided to make the case of Plaskon, a urea formaldehyde plastic, which forms unusually light and durable articles when molded under high pressures. The use of a plastic as a material for the case has several important advantages over porcelain enameled iron which was formerly used. First, it enabled the manufacturer to reduce the weight of the scale from 154 lb. to 55½ lb. Second, it eliminated much finishing and assembly work. Third, there is no danger of the finish wearing or chipping off for the material is the same all the way through.





(Left) Special hydraulic press built for forming large plastic moldings. Air inlet grilles can be seen above press. Floor has been cut away to show base of press. (Below) Section of bank of glass wool filters used for cleaning air in press room.

GETTING DOWN TO FUNDAMENTALS

9—Calculated Values of Coefficient U

APPLYING the theory of steady heat flow, and therefore making use of formulas which involve the conductivity of the solid materials, air spaces, and air swept surfaces, values of the coefficient U have often been calculated. Such calculations have been revised from time to time as new and seemingly more trustworthy test values of the fundamental factors have been announced. Calculators have usually arranged their results into the form of tables. Because of this there are many such sets of tables in existence and many of the values given in one set of tables do not agree with those in other sets.

Tables appearing in older textbooks, handbooks, and similar publications, usually gave values for only a relatively few constructions, but covered the materials and methods of construction currently in use when the tables appeared. With the increased application of heat insulation materials in building construction the later tables have become more complex in order to present values for the constructions which incorporate these insulations. As a result the tables have become continuously more bulky. Bulk is also added when there are included values which differ from each other only in slight degree—so slight in fact that it is doubtful if the differences are really significant.

A New Set of Tables

A new set of tables has been prepared which aims to reduce the bulk of those now in existence without sacrifice of any essential and meaningful values of U. Calculating constants used in preparing these tables are in the main those given in a table in the preceding article of this series. Insofar as possible, the actual dimensions of materials are those used in the calculations rather than nominal dimensions. Thus what ordinarily passes as 1-in. lumber has been assumed to really be 25/32 in. thick; studs in wood frame walls are taken as 3⅝ in. thick instead of their nominal 4 in. thickness; plaster is assumed to be applied to a thickness of ½ in., although the actual thickness varies considerably as applied. It is assumed that there is no meaningful difference in the amount of heat passing through a wood lath and plaster construction and that passing through a similar construction using metal lath and plaster—an assumption believed to be well justified.

Since transmitted heat passes through all building constructions when there is a difference in temperature between the two surfaces and since those differences may at some time exist in practically all of the constructions surrounding a heated or cooled room it is necessary to include a value of practically every type of construction in common use if the tables are to be complete. In order to secure this completeness and at the same time arrange the material in compact and readily usable form it has been found necessary to prepare a series of 10 separate tables.

Throughout these tables, values of U are for direct substitution in the equation (1) for calculating transmitted heat as previously given in these articles. They are the so-called "overall" values and include the resistances at both surfaces. They are therefore the air-to-air values. In all tables the figures are in B.t.u. per hour per square foot area per degree temperature difference and assume a 15 mile per hour wind on the outer surface, if exposed, and so-called "still air" on interior surfaces.

In inserting the computed values into the tables it was necessary to decide how many figures to show in each case. Calculations were in all cases carried to three figures, regardless of how many decimals appeared in the factors entering the calculations. Reciprocals were then obtained by slide-rule and were rounded to the nearest two-figure number. It is believed that this method gives values amply close in view of serious doubts about the correctness of some of the calculation factors which are set by judgment.

In these tables, as in all other tables of similar nature, it should be noted that there is no absolute way of knowing the percentage of error involved when the figures are applied. There seems to be a tendency either to consider that such figures are precisely correct on the one hand, or else to ignore them completely and resort to pure rule-of-thumb on the other. A posi-

Previous articles have described the nature and direction of flow of the heat quantities on which the usual estimate is based. They are (a) transmitted heat, (b) heat from filtration air, and (c) heat from ventilation air, and may be expressed by the following equations:

$$\text{Transmitted Heat} = H = AU\,(t_i - t_o) \quad (1)$$

$$\text{Heat from Filtration Air} = F = \frac{C(t_i - t_o)}{55} \quad (2)$$

$$\text{Heat from Ventilation Air} = V = \frac{C_v(t_i - t_o)}{55} \quad (3)$$

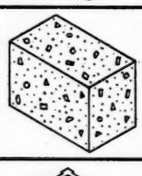
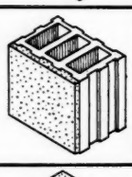
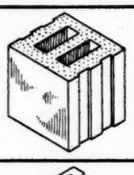
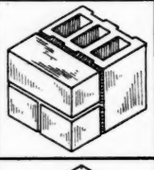
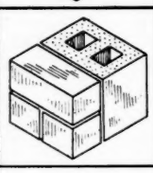
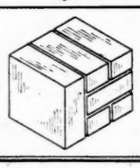
In these equations: H, F, and V are all in B.t.u. per hr.:

A = Area, sq. ft. of surface through which heat passes
U = The transmission coefficient, air to air
C = Volume of filtration air flowing, cu. ft. per hr.
C_v = Volume of ventilation air flowing, cu. ft. per hr.
t_i = Temperature of indoor air, °F.
t_o = Temperature of outdoor air, °F.
1/55 = 0.018 = heat to raise 1 cu. ft. of air at 70° through 1°

Tables were presented indicating current ideas as to what values should be used for t_i and t_o under both summer and winter conditions. Methods of finding values of C in equation (2) and C_v in equation (3) were described, with tables. Thus all the necessary data for making calculations of the heat from filtration air and the heat from ventilation air have been presented.

We are now considering the fundamentals surrounding the calculation of the transmitted heat, especially as accomplished by equation (1). As values of t_i and t_o have already been fixed, our principal consideration is to present suitable values of U, the transmission coefficient, air to air. In the preceding article the nature of the equation was considered and a formula and suitable values for computing U were presented.

TABLE 1.

CONSTRUCTION NO.	MASONRY WALLS — Figures are in B.t.u. per hour per square foot per degree temperature difference, air to air, still air inside, 15 m.p.h. wind outside. — INTERIOR MATERIALS → / ← EXTERIOR MATERIALS		THICKNESS, INCHES	A	B	FURRING STRIPS USED C	D	E	F	G	H	I
				Plain Wall, no Plaster	½" Plaster direct on Walls, no Furring	½" Plaster on Wood Lath or on Metal Lath or on ½" Plasterboard	½" Painted Plasterboard, no Plaster	½" Plaster on ½" Rigid Insulation	½" Plaster on 1" Rigid Insulation	½" Plaster on 2" Furring 1⅝" Rock Wool Fill	½" Plaster on 2" Furring ½" Flexible Insulation	½" Plaster on 1½" Corkboard set in ½" Cement Mortar
1		Common Brick Throughout	4	0.63	0.57	0.33	0.35	0.24	0.18	0.12	0.21	0.15
2			8	0.44	0.39	0.26	0.26	0.20	0.16	0.11	0.18	0.13
3			12	0.31	0.30	0.22	0.22	0.17	0.14	0.10	0.15	0.12
4			16	0.25	0.24	0.18	0.19	0.15	0.14	0.09	0.14	0.11
5		4" Face Brick, remainder Common Brick	4	0.81	0.72	0.35	0.40	0.26	0.19	0.13	0.22	0.16
6			8	0.49	0.46	0.29	0.30	0.22	0.16	0.12	0.19	0.14
7			12	0.35	0.34	0.24	0.24	0.20	0.15	0.10	0.16	0.12
8			16	0.28	0.26	0.20	0.20	0.16	0.13	0.09	0.15	0.11
9		Limestone or Sandstone	8	0.68	0.62	0.35	0.37	0.25	0.18	0.13	0.21	0.15
10			12	0.56	0.51	0.31	0.33	0.23	0.17	0.12	0.20	0.14
11			16	0.47	0.44	0.28	0.30	0.21	0.16	0.12	0.19	0.14
12			24	0.36	0.34	0.24	0.26	0.19	0.15	0.11	0.17	0.13
13		Concrete	8	0.68	0.62	0.35	0.37	0.25	0.19	0.13	0.21	0.15
14			10	0.62	0.56	0.33	0.35	0.24	0.18	0.12	0.20	0.15
15			16	0.47	0.44	0.28	0.30	0.21	0.16	0.12	0.19	0.14
16			20	0.41	0.38	0.26	0.27	0.20	0.15	0.11	0.17	0.13
17		Hollow Clay Tile With 1" Stucco Exterior Finish	4	0.53	0.49	0.30	0.32	0.23	0.17	0.12	0.19	0.14
18			8	0.39	0.37	0.25	0.26	0.20	0.15	0.11	0.17	0.13
19			10	0.35	0.33	0.23	0.24	0.18	0.14	0.11	0.16	0.12
20			12	0.31	0.29	0.21	0.22	0.17	0.13	0.10	0.15	0.12
21			16	0.24	0.23	0.18	0.19	0.15	0.12	0.09	0.14	0.11
22		Hollow Gypsum Tile, 1" Stucco Ext. Fin.	4	0.33	0.31	0.22	0.23	0.18	0.14	0.10	0.16	0.12
23		Cinder Blocks With one Air Cell Across Heat Flow	8	0.42	0.39	0.26	0.27	0.20	0.16	0.11	0.18	0.13
24			12	0.36	0.34	0.24	0.25	0.19	0.15	0.11	0.17	0.13
25		Cement Blocks With one Air Cell Across Heat Flow	8	0.56	0.52	0.31	0.33	0.23	0.17	0.12	0.20	0.14
26			12	0.49	0.46	0.29	0.30	0.22	0.16	0.12	0.19	0.14
27		4" Brick or 4" Cut Stone with Hollow Clay Tile Backing of This Thickness	6	0.37	0.35	0.24	0.25	0.19	0.16	0.11	0.17	0.13
28			8	0.36	0.34	0.24	0.25	0.19	0.15	0.11	0.17	0.13
29			10	0.32	0.31	0.22	0.23	0.18	0.14	0.10	0.16	0.12
30			12	0.28	0.26	0.20	0.20	0.16	0.13	0.10	0.15	0.11
31		4" Brick or 4" Cut Stone with Concrete Backing of This Thickness	6	0.61	0.56	0.33	0.35	0.24	0.18	0.13	0.20	0.15
32			10	0.51	0.47	0.30	0.31	0.22	0.17	0.12	0.19	0.14
33			16	0.41	0.38	0.26	0.27	0.20	0.15	0.11	0.17	0.13
34		4" Brick Veneer — With Cinder Block Backing of This Thickness	8	0.35	0.33	0.24	0.24	0.19	0.14	0.11	0.16	0.12
35			12	0.31	0.30	0.22	0.22	0.17	0.14	0.10	0.16	0.12
36		4" Brick Veneer — With Cement Block Backing of This Thickness	8	0.45	0.42	0.27	0.29	0.21	0.16	0.12	0.18	0.13
37			12	0.40	0.38	0.26	0.27	0.20	0.15	0.11	0.17	0.13
38		4" Cut Stone With Common Brick Backing of This Thickness	8	0.37	0.35	0.24	0 25	0.19	0.15	0.11	0.17	0.13
39			12	0.28	0.27	0.20	0.21	0.16	0.13	0.10	0.15	0.12
40			16	0.23	0.22	0.17	0.18	0.15	0.12	0.09	0.13	0.11

tion in between these two extremes is the correct one.

Those who put their trust implicitly in tables of this kind often try to make comparisons of constructions, and especially of insulated constructions, by direct comparisons of the values. Within limits this is justifiable but there is no way to set the limits. It is assumed, for instance, by some people that because one construction is given a value of 0.40 in the tables while

another has a value of 0.39 that there is really a difference in practical application of 1/40 or 2.5% between the two constructions. Considering the circumstances and the way the values are arrived at, any such conclusion is extremely questionable. It is quite possible that the two constructions will, in practice, each require precisely the same size plant and the same amount of fuel. There is much to be said in favor of rounding the figures to the nearest five instead of to the nearest figure. Again the word of warning is not to try to attribute to the figures a degree of accuracy which they do not possess. If the practice of rounding to the nearest five was followed it will be noted that both of the two constructions just mentioned would have a value of 0.40 and would be considered equal. In some cases however comparisons are helpful and legitimate. Thus if one construction has a value of 0.40 while another has a value of 0.20, the difference between them is certainly significant and it would be entirely reasonable to expect that a plant could be considerably smaller and should require less fuel if placed in a building using the latter construction than if placed in a building using the former. Just how much smaller and how much less fuel would be used are points on which there is no definite proof and no set rules of practice, but where judgment must be used.

Tables for Side Wall Constructions

Presented here in Tables 1 and 2 are values covering the great majority of the side wall constructions now in use. For convenience Table 1 includes masonry walls while Table 2 gives similar values for wood frame construction.

Table 1 includes side walls using brick, stone, concrete, and prepared building blocks together with veneers of those materials and with interior constructions and insulations of nine kinds. No values are shown for walls where bright aluminum foil is used as an insulator, but for such a construction with a furred space faced on one side with such a foil instead of any of the insulations shown, the coefficient approximates those appearing in column E and can be so assumed for estimating purposes, but should be calculated if further accuracy is desired. In using values from the table for constructions where building blocks are used it should be noted that the values given are for use of the blocks in such a way that one air space faces the direction of heat flow. Obviously these blocks could be put into position in the construction in such a way that more than one air space would face the air flow. No values are included for this situation. Where thicknessess of materials other than those shown in the tables are involved the values can often be estimated by interpolation between those shown.

Table 2 includes values for most constructions involving wood frame walls and for brick veneer over a wood frame construction. In the case of the brick veneer wall there is an air space between the brick and the wood sheathing but this is not taken into account in the values in the table. In some construction this space is largely filled with mortar because the mortar cannot be wiped clean. Wire nails are also often driven into the sheathing to tie the brick to the wood frame. It is believed that the values given bear out the experience that a brick veneer wall is about equivalent to a frame wall using clapboard or siding.

Floor and Ceiling Tables

Floors and ceilings of both concrete and wood frame construction are in common use and Tables 3 and 4 give values of U for use with them. In both cases various methods of applying insulation are included. It will be noted that Table 3 includes concrete floors laid directly on the ground and floor and ceiling combinations where the floor slab can be considered a part of the ceiling of a room on a floor below. The typical

TABLE 2.

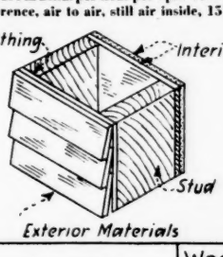
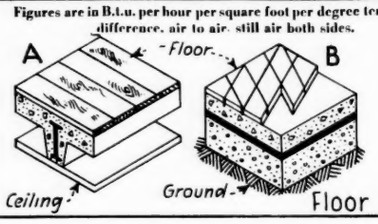
WOOD FRAME WALLS			A	B	C	D	E	F	G	H
Construction No.	Exterior Material ↓	Figures are in B.t.u. per hour per square foot per degree temperature difference, air to air, still air inside, 15 m.p.h. wind outside.  Interior Materials →	← Type Sheathing	Plain Wall - no Plaster ½" Plaster Board on Studding	½" Plaster on Wood Lath on Metal Lath, or on ½" Plaster Board.	½" Plaster on ½" Rigid Insulation on Studding	½" Plaster on 1" Rigid Insulation on Studding	½" Plaster on 1½" Corkboard on Studding	Same as B, but with Stud faced one side with bright Aluminum Foil	Same as B plus ½" Flexible Insulation against Sheathing	Same as B plus 3⅝" Rock Wool between Studding
41	Wood Siding or Clapboard	Wood Sheathing - 1"		0.25	0.24	0.19	0.15	0.11	0.19	0.17	0.060
42		Rigid Insulator Sheathing-½"		0.23	0.22	0.18	0.14	0.11	0.18	0.16	0.059
43		Plaster board Sheathing - ½"		0.28	0.27	0.20	0.16	0.12	0.21	0.18	0.062
44	Wood Shingles	Wood Sheathing - 1"		0.24	0.23	0.18	0.14	0.11	0.18	0.16	0.059
45		Rigid Insulator Sheathing ½		0.19	0.19	0.15	0.12	0.10	0.15	0.14	0.056
46		Plaster board Sheathing - ½"		0.24	0.24	0.19	0.15	0.11	0.19	0.16	0.060
47	Stucco	Wood Sheathing - 1"		0.31	0.29	0.22	0.16	0.12	0.22	0.19	0.063
48		Rigid Insulator Sheathing - ½"		0.27	0.26	0.20	0.16	0.12	0.20	0.18	0.062
49		Plaster board Sheathing - ½"		0.40	0.38	0.26	0.19	0.14	0.27	0.22	0.066
50	Brick Veneer	Wood Sheathing - 1"		0.23	0.23	0.18	0.14	0.11	0.18	0.16	0.059
51		Rigid Insulator Sheathing - ½		0.23	0.22	0.18	0.14	0.11	0.18	0.16	0.059
52		Plaster board Sheathing - ½"		0.31	0.30	0.22	0.17	0.12	0.22	0.19	0.063

TABLE 3.

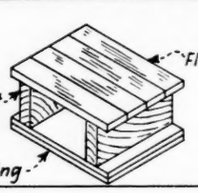
CONCRETE FLOORS & CEILINGS					A	B	C	D	E
Construction No.	Construction Type	Figures are in B.t.u. per hour per square foot per degree temperature difference, air to air, still air both sides.  Floor Construction →		Material under Floor ↓ Thickness of Concrete	Bare Concrete Floor	Y. P Flooring on Wood Sleepers Embedded in Concrete	H.W Flooring on Y.P Sub-Flooring on Wood Sleepers Embedded in Concrete	1" Tile or Terrazzo on Concrete	¼" Battleship Linoleum on Concrete
62	A	Floor Slab Exposed No Finished Ceiling Beneath.		4	0.63	0.39	0.30	0.60	0.43
63				6	0.57	0.37	0.28	0.55	0.40
64				8	0.52	0.35	0.27	0.50	0.38
65				10	0.48	0.33	0.26	0.46	0.35
66	A	½" Plaster. Direct on Under Surface of Concrete		4	0.58	0.37	0.28	0.55	0.40
67				6	0.52	0.35	0.27	0.50	0.38
68				8	0.48	0.33	0.26	0.47	0.36
69				10	0.45	0.31	0.25	0.43	0.34
70	A	¾" Plaster on Wood or Metal Lath. (Suspended or Furred Ceiling)		4	0.37	0.27	0.22	0.36	0.29
71				6	0.35	0.26	0.21	0.34	0.28
72				8	0.33	0.25	0.21	0.32	0.26
73				10	0.31	0.24	0.20	0.30	0.25
74	A	½" Plaster on ½" Rigid Insulation (Suspended or Furred Ceiling)		4	0.24	0.20	0.17	0.24	0.21
75				6	0.23	0.19	0.16	0.23	0.20
76				8	0.22	0.18	0.16	0.22	0.19
77				10	0.22	0.18	0.16	0.21	0.19
78	A	½" Plaster on 1½" Corkboard in 1½" Cement Mortar on Concrete		4	0.15	0.13	0.12	0.15	0.13
79				6	0.14	0.13	0.11	0.14	0.13
80				8	0.14	0.12	0.11	0.14	0.13
81				10	0.14	0.12	0.11	0.14	0.12
82	B	Stone Concrete Directly on Ground, no Insulation, no Cinder Concrete		4	1.05	0.52	0.37	0.96	0.59
83				6	0.89	0.48	0.34	0.83	0.54
84				8	0.78	0.44	0.32	0.73	0.49
85				10	0.69	0.41	0.31	0.65	0.46
86	B	3" Cinder Concrete on Ground, Insulation on top of this, under Stone Concrete.	No Insulation	4	0.64	0.40	0.30	0.61	0.44
87			No Insulation	8	0.53	0.35	0.27	0.51	0.38
88			1" Rigid Insulat.	4 or 8	0.21	0.18	0.15	0.21	0.18
89			2" Corkboard	4 or 8	0.12	0.11	0.10	0.12	0.11

sketches included make the constructions clear.

In Table 4 are given values for wood frame floors and ceilings where the floor is a part of the ceiling of the room below. Values here given do not include the case where the ceiling can be considered a part of the attic roof. It will be noted that in this table a distinction is made between wood lath on plaster and plaster on metal lath. Both are in wide use. Metal lath is used on ceilings in many cases even though not used on side walls because of the belief that plaster falls are much less likely where metal lath is used.

In an early issue the remainder of the tables for determining calculated values of U for use in Equation (1) will be presented.

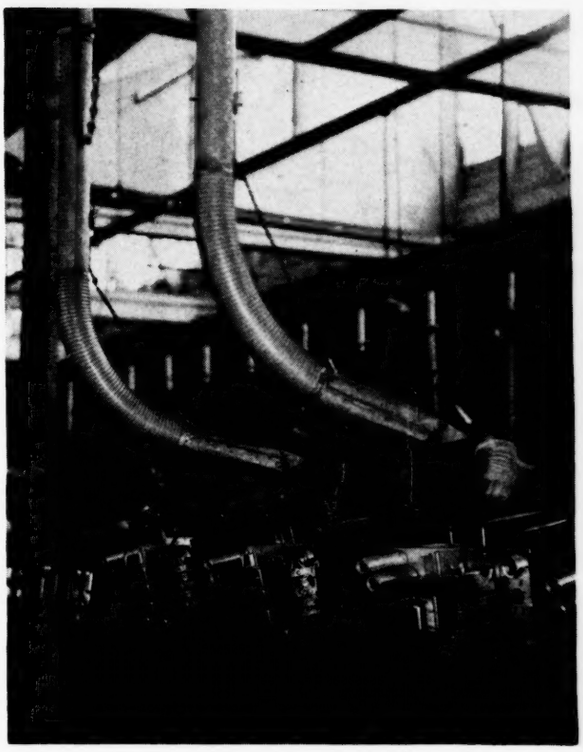
TABLE 4.

WOOD FRAME FLOORS & CEILINGS			A	B	C	D	E
Construction No.	Ceiling Material ↓	Figures are in B.t.u. per hour per square foot per degree temperature difference, air to air, still air both sides.  Type of Flooring → Insulation Between Joists ↓	No Flooring	Flooring (Y.P.) on Joists	Flooring (Y.P.) on ½" Rigid Insulation on Joists	H.W. Flooring on Y.P. Sub-Flooring on Joists	¼" Battleship Linoleum on Y.P. Flooring
55	No Ceiling	No Insulation	—	0.45	0.27	0.34	0.34
56	Plaster on Wood Lath or 3/8" Plasterboard	No Insulation	0.60	0.28	0.20	0.24	0.24
57	Plaster on ½" Rigid Insulator	No Insulation	0.34	0.21	0.16	0.18	0.18
58	Metal Lath Plaster	½" Rigid or Flexible	0.25	0.17	0.14	0.15	0.15
59	Metal Lath Plaster	Bright Aluminum Foil	0.29	0.22	0.17	0.19	0.19
60	Metal Lath Plaster	3 5/8" Rock Wool	0.066	0.062	0.056	0.059	0.059
61	1½" Corkboard & Plaster	No Insulation	0.16	0.12	0.10	0.11	0.11

Radio Factory Protects Workers from Fumes with Exhaust System

EXHAUST systems for removing unpleasant or unhealthy fumes and dusts from various manufacturing operations in industrial work is a good source of modernizing work for the contractor. However, they often involve highly specialized problems which in turn require extreme care in design to insure the performance of their required purposes. A system of this type was recently installed in a Chicago radio manufacturing plant and required more than a year of experimental work before its peculiar requirements were met.

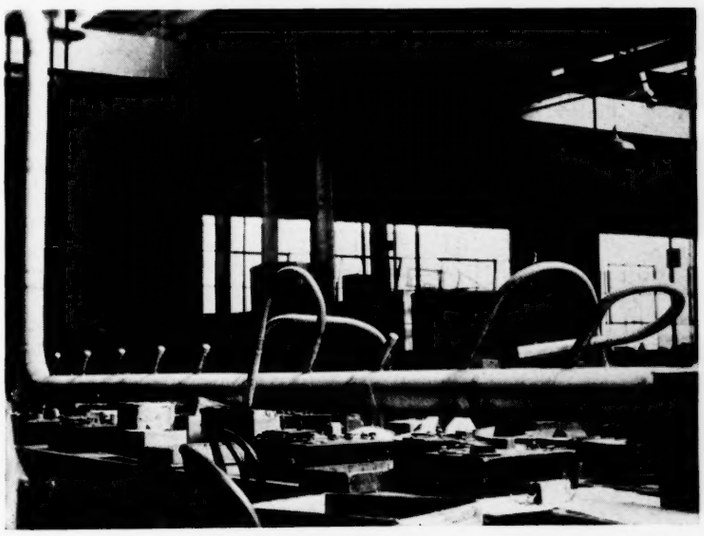
A large manufacturer of radio sets, The Wells-Gardiner Company, anxious to cooperate with the Chicago Board of Health to protect its employes' health, desired a system that would remove lead and resin fumes present in soldering operations. This company turns out a large volume of radio sets of many sizes. Five production lines are operated in the assembly plant. In these lines bare chassis begin at one end, intermittently stop at 45 points en route, and move forward until upon arrival at the other end they are complete radio sets. Operators are seated at each of the 45 points where they add various parts, a number of which are soldered into the chassis. It is there that the soldering irons give off lead fumes and dust from the resin used as flux.



Note flexible tube and fan shaped nozzle for gathering in fumes

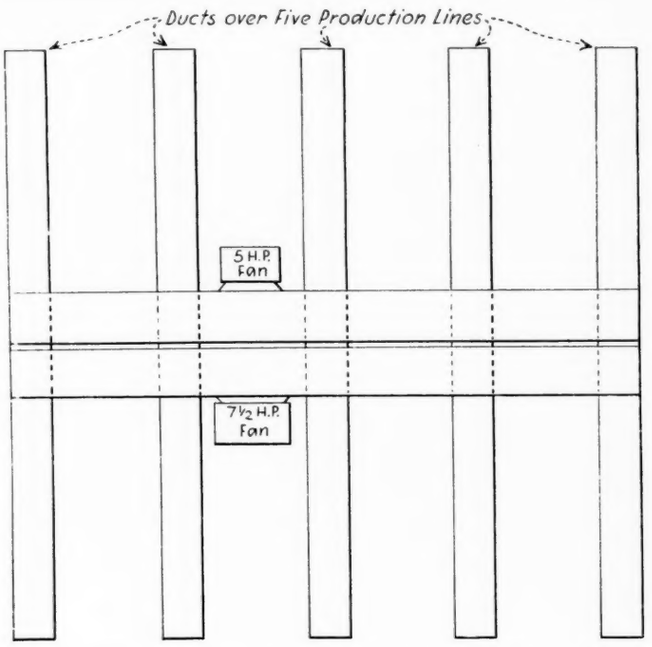
Were all radio sets the same in size and were all soldering operations done at the same points in the line, removal of fumes would have been comparatively simple. But a large manufacturer makes sets of many different sizes and soldering is done at different points on the line on different sizes of sets. In fact soldering could conceivably be done at any one of the 45 places in a production line. More than that, chassis for large console sets are naturally soldered at a point much higher above the table than a small auto radio set. Thus two of the first requirements of this exhaust system were that (1) provision to carry off fumes from any one of the 45 points on a production line and (2) fumes must be removed from a point 6 to 18 in. above the table lest the fumes diffuse into the room.

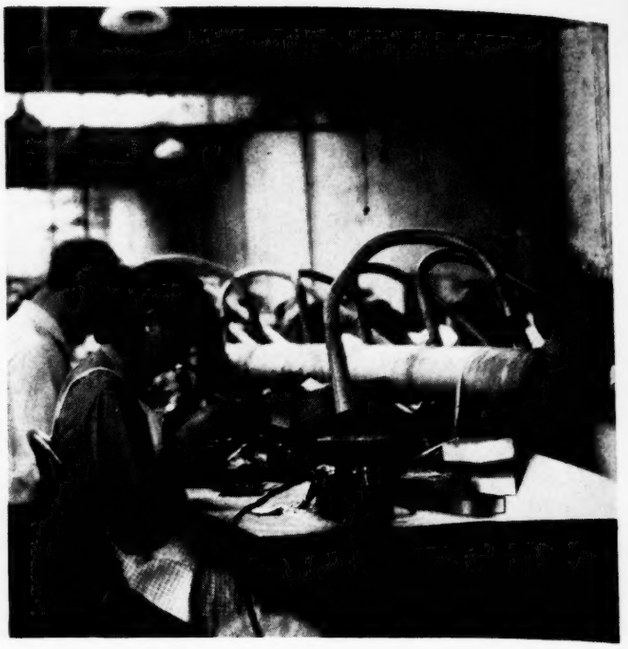
Added to these was the question of operating economy, for production varies considerably in a radio plant. One day perhaps all five production lines are turning out radio sets and on the next only one line will be in operation. This demands a system which can handle the load of all five lines at once or be partly closed down to exhaust fumes from only one line. In short, what this factory needed was a huge vacuum cleaner with octopus-like arms which could reach out to all parts of the assembly plant and draw off dust and lead fumes wherever soldering was being done. More than that it needed a system which could exhaust fumes from a few points but with sufficient power in reserve to handle many points at once when the plant was in full production.



Work table where work is stationary and inlets are fixed. Unused outlets are plugged when not in use.

With these problems before them W. C. Ernst, superintendent of the factory, A. H. Zimmerman, of the Chicago Board of Health, and the Chicago Blowpipe Company, the contractor, set to working out a system which would satisfy all these specifications. Several designs were tried on a small scale under actual working conditions be-





(Left) Layout of radio factory showing trunk lines and branches. (Right) Removing lead fumes where work is stationary.

fore the present design was considered most practical. In its installed form it comprises a number of features other contractors may find useful in laying out systems having somewhat similar requirements.

The system as installed comprises five ducts running above each of the five production lines for their entire lengths of 110 ft. each. At the middle of each line these trunks are connected to separate ducts leading to two fans; one a 5-hp. and the other to a 7½-hp. fan. The smaller fan can handle any two lines and the larger any three, while the two operating at once can handle all five lines. With a system of dampers any one line or any combination of lines can be exhausted of fumes.

From the illustrations it will be seen how the contractor solved the problem of removing fumes at different heights above the tables. A sleeve arrangement at the middle of the pipe extending down to the tables permits the raising or lowering of the lower half to adjust it to the height of the radio being soldered. A clamp holds the adjustment in place. At the lower end of this pipe is a flexible tube which permits adjustment to suit the operator. This terminates in a fan shaped nozzle serving to gather in the fumes from the soldering iron.

The system is designed to handle a maximum of 15 inlets on a line at one time. Those not in use are either cut off by a damper in the pipe or the entire pipe is removed at the tee in the main trunk duct and the tee capped.

The system has been in operation for several months under all production conditions and has now been fully approved by both the State and City Boards of Health. From all appearances its design has met all the demands made on it. More than that its flexibility is such that no matter what changes the future may bring in radio manufacturing, it is likely that the system will be capable of handling the exhaust of soldering fumes.

Dehumidifying Pays Its Cost in Color Printing Plant

BEFORE Robt. Teller Sons & Dorner, New York color printers, modernized their pressroom with a dehumidifying system, their output depended largely on weather conditions. One of the chief problems in four-color printing is the total removal of old ink, film, and foreign matter from plates. Unless the humidity is below 65%, removal of the undesirable substances is effected only with great difficulty. Experience has shown that color printing on any but entirely clean plates produces unsatisfactory output.

If orders were "rush" sometimes printing was attempted despite adverse weather. Usually, however, the management deferred printing until a more auspicious time. This caused unavoidable loss, delays, and general dissatisfaction.

The owners decided to modernize the plant and a compressor, fan, cooling coils, and sheet metal duct system, with an outlet in each of two rooms, were installed. Except for the compressor, the apparatus was placed entirely overhead. The fan, at one end of the duct, picked up room air, passed it through the cooling coils, then discharged the dehumidified air through the duct to the outlets. Full recirculation is practiced and the air delivered now ranges between 45 and 65% relative humidity, according to atmospheric conditions.

Benefits are twofold. First, superior workmanship; second, absence of shutdowns and delays. The saving effected has in the few months during which the system has been in operation repaid its cost many times over.

Engineering Gas Conversion Burner Installations

6—Results Obtained by Properly Engineered Burner Jobs

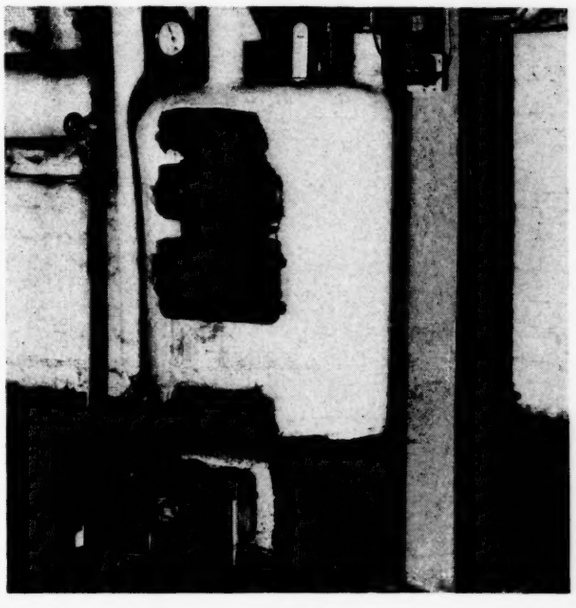
By ALFORD G. CANAR

YOU have read, in the preceding installments, a rather lengthy dissertation on how to engineer a conversion burner job before and after the installation is made. The procedure to follow in sequence was given and the explanation of how to do it was followed by the explanation of why to do it.

It all resolves itself into the simple application of such fundamental engineering principles as are applicable to the combustion of gas and the transmission of heat. Space heating, in its final analysis, is merely combustion of gas coupled with transmission and transference of heat.

Since gas is still the most expensive fuel in most communities as compared with liquid and solid fuels, it becomes necessary that every B.t.u. possible be transferred from the gases of combustion to the heating medium and that every B.t.u. put into the heating medium be delivered to the space to be heated and forced to take care of the heat demand of the house with the highest possible thermal efficiency. In other words, we should achieve the highest possible thermal efficiency of space heating or house-heating within the limitations of what we have to work with in each particular case.

The application of the engineering program as outlined, especially that to be applied after the burner installation, will make it possible to obtain the highest possible thermal efficiency of space heating, which also means that the particular job will heat the space satisfactorily for the minimum cost of operation. Naturally this latter feature is of interest to all gas companies who have entered the space heating field with conversion burners, because the cheaper jobs can be made to heat, the more satisfied customers on the lines, and the greater the number of jobs which can be obtained from the potential market available. A satisfied customer is the best salesman that a gas company can have because he will broadcast his satisfaction and interest his friends, which will bring more new business at no direct cost for advertising.



Those readers who are rather new to the conversion burner field or who have not had very much experience with it may question the results possible, or it may seem that there is a very long program to follow to properly engineer a job, and may wonder if it is worthwhile. It doesn't take any longer to properly engineer a job prior to the installation than it does to poorly engineer it. However, after the installation of the burner it does require a little more time to properly engineer the job, perhaps one hour longer in the average case. This should always be done to every job right after the installation of the burner so that the job will be stisfactory right from the start. Don't wait until you receive a complaint before you attempt to make it a good job because you are inviting the loss of a job. Every lost job costs a goodly number of dollars and provides sales resistance very difficult to be overcome in the future.

It has been a guiding principle with the author that facts are the only logical things to talk about. In other words, the statements one makes should be backed up by the actual results. Therefore, he takes the liberty of citing a series of cases where jobs, which had been poorly or indifferently engineered, were later properly engineered so that they provided satisfactory heating. The saving or reduction in operating costs was computed taking as a basis the cost of the total gas consumption for that portion of the heating season prior to the day on which the job was properly engineered and the cost of the total gas consumption for the balance of the heating season after the work was done.

Since the cubic feet of gas consumption per degree-day is higher during the milder weather in fall and spring than it is during the colder portion of the winter, only those cases where a comparable mild and colder period occurred before and after engineering the job will be cited. The best case would be the one where the job was operating an entire heating season and where approximately fifty per cent of the heating season

passed before and approximately fifty per cent of the heating season occurred after the job was engineered. This would give the best possible basis of comparison and only such cases will be considered.

Cases will be cited showing the reductions in operating costs due to:

1. Reducing a strong draft condition to an operating minimum draft.
2. Removal of firebrick lining from the firepot of a steel furnace.
3. Operating a furnace with the indirect damper closed so that all the heating surfaces will be utilized.
4. Raising the hourly gas consumption to provide greater heat input.
5. Reducing the hourly gas consumption where an excessive rate had been used.
6. Changing the position of a burner.
7. Reducing excess air.
8. Changing from one burner to another which would permit better application of heat to the firepot.
9. Baffling boilers and furnaces so as to assist the boiler or furnace to absorb more heat from the gases

TABLE 1.—RESULTS OF ENGINEERING CONVERSION BURNER INSTALLATIONS IN BOILERS

No.	Boiler		Kind of Heat	Flue Temp.—°F.		Flue Loss—%		Gas Rate Cu. Ft. Per Hr.		Operating Cost per Heating Season—$	Reduction in Operating Cost—%	Remarks How Engineered†
	Name*	Number		Before	Reduction	Before	Reduction	Before	After	Before		
Round Cast Iron Boilers												
1	A	S-2504	Steam	625	145	24.4	4.0	310	310	270	14.1	Baf.
2	A	W-2504	Hot water	530	110	21.6	3.0	150	150	230	22.0	Baf.
3	A	W-3104	Hot water	570	70	22.7	1.3	300	300	346	19.3	Baf.
4	A	W-2205	Hot water	520	90	23.3	3.8	210	210	198	23.7	Baf.—Note 1
5	A	S-2805	Steam	450	−35	19.3	−0.7	310	330	346	20.7	Baf.—In. gas
6	A	S-2805	Steam	480	85	19.9	2.0	305	305	246	9.8	Baf.
7	A	4-31-S	Steam	570	80	22.9	2.0	360	380	533	26.4	Baf.—In. gas
8	A	4-28-S	Steam	350	−40	16.8	−1.7	260	280	243	33.0	Baf.—In. gas—Clean.
9	A	W-2506	Hot water	380	90	19.0	2.0	180	180	193	16.6	Baf.
10	Af	22	Steam	540	140	24.6	4.3	140	140	188	29.2	Baf.
11	AC	1126	Hot water	580	120	24.5	4.1	210	210	400	19.7	Baf. —De. air
12	WM	5-W-22	Hot water	485	30	20.8	0.5	245	245	227	18.1	Baf.—De. dr.
13	WM	28-3-S	Steam	530	110	22.3	2.8	327	327	393	16.0	Baf.—Clean.
14	WM	5-W-25	Hot water	500	65	21.1	1.6	225	225	166	24.1	Baf.—De. dr.
15	HL	523	Steam	570	130	19.7	1.9	240	215	312	40.3	Baf.—De. gas
16	NA	1021	Steam	700	165	24.5	3.3	240	170	207	17.4	Baf.—De. gas
17	S	440	Hot water	370	80	19.8	3.8	140	140	160	20.7	Baf.—De. air
18	NP	2027	Steam	535	90	22.1	2.3	292	300	398	35.2	Baf.—In. gas
19	R	34-23	Steam	555	85	28.2	6.1	125	145	198	23.7	Baf.—In. gas—De. air
20	N	32-4-S	Steam	620	50	28.2	4.0	300	300	303	18.1	Baf.—De. dr. —De. air
21	Ri	295-T	Hot water	550	50	22.6	1.4	300	280	246	28.8	Baf.—De. gas—Clean.
22	Ri	264-R	Steam	625	135	23.7	3.0	270	290	443	10.1	Baf.—In. gas
23	A	5-34-W	Hot water	450	70	19.8	2.5	350	350	375	21.2	De. dr.
24	WM	4-W-25	Hot water	510	70	21.3	2.5	215	215	253	17.5	De. dr.
25	A	W-2505	Hot water	480	30	23.6	3.1	215	240	199	9.6	In. gas
26	A	5-S-28	Steam	375	35	19.0	2.2	285	300	287	10.4	In. gas—De. dr.
27	Ra	431	Steam	490	90	20.1	0.2	430	475	448	20.1	De. gas—De. dr.
Sectional Cast Iron Boilers												
28	Al	8 Sec.	Hot water	640	100	36.7	15.9	125	125	131	11.7	Baf.—De. air
29	Al	6 Sec.	Hot water	680	90	28.1	5.1	128	120	115	30.5	Baf.—De. gas—De. air
30	IR	2-W-6	Hot water	425	45	20.5	3.3	225	225	293	16.7	Baf.
31	IW	S-2909	Steam	530	125	30.4	11.0	730	780	940	46.5	Baf.—In. gas—De. air —De. dr.
32	E	S-108	Steam	600	160	33.4	14.7	320	255	324	20.7	Baf.—De. gas—De. air —De. dr.
33	Ra	356	Steam	600	40	30.0	6.8	590	620	693	17.6	Baf.—In. gas—De. air —De. dr.
34	H	827	Hot water	640	150	24.8	3.8	340	340	224	18.8	Baf.
35	WM	0255	Steam	520	80	22.7	2.2	580	490	470	24.8	Baf.—De. gas
36	Am	265	Steam	455	85	20.5	2.6	240	240	288	14.6	Baf.
37	C	517 M	Steam	430	−50	21.9	−1.6	155	180	216	12.5	In. gas—De. air
38	IR	1-W-7	Hot water	425	−25	19.4	−0.6	163	180	175	12.0	In. gas
39	Ro	S-22-6	Steam	430	40	22.9	3.8	390	390	514	7.4	De. dr.
40	M	18-S	Steam	480	105	19.8	2.8	190	190	286	7.4	De. air
Steel Boilers												
41	P	R-20-6	Steam	340	100	18.0	3.7	435	435	483	20.2	Sp. baf.
42	K	2	Steam	250	50	16.0	1.7	235	235	265	7.8	Sp. baf.
43	K	3	Steam	280	40	16.8	1.8	600	515	467	15.6	De. gas—De. dr.
44	K	3	Steam	260	20	17.8	3.1	530	530	772	26.7	De. air—De. dr.
45	K	1 A	Hot water	280	−20	17.0	0.7	360	380	380	21.5	In. gas—Note 2
46	K	2	Steam	—	—	—	—	365	365	465	20.8	De. dr.
47	K	2	Hot water	—	—	—	—	355	355	359	15.1	De. dr.

*A—Arco; AC—Abram Cox; Af—Arcoflash; Al—Arcola; Am—American; C—C.H.W. Co.; E—Economy; H—Hercules; HL—Hardin Lavin; IR—Ideal Redflash; IW—Ideal Watertube; K—Kewanee; M—Model; N—Niagara; NA—National Acme; NP—New Premier; P—Pacific; R—Riraco; Ra—Radiant; Ri—Richardson; Ro—Royal; S—Spence; WM—Weil McLain.

†Baf.—Baffled; Clean—Cleaned inside of boiler with compound; De. air—Decreased excess air; De. dr.—Decreased excessive draft; De. gas—Decreased gas rate; In. gas—Increase gas rate; Sp. baf.—Baffled all tubes with spirals; Note 1—Raised burner from 4 in. below to 1 in. above grate line; Note 2—Rebuilt broken down baffle shelf in setting.

TABLE 2.—RESULTS OF ENGINEERING CONVERSION BURNER INSTALLATIONS IN FURNACES

No.	Furnace		Kind of Furnace	Flue Temp.—°F.		Flue Loss—%		Gas Rate Cu. Ft. Per Hr.		Operating Cost per Heating Season—$	Reduction in Operating Cost—%	Remarks
	Name*	Number		Before	Reduction	Before	Reduction	Before	After	Before		How Engineered†
48	Ho	45	Cast iron	505	85	26.0	6.0	160	180	142	18.3	Baf.—In. gas
49	Ho	45	Cast iron	750	300	27.8	8.8	220	220	187	19.3	Baf.—Clo. damp.
50	Su	22C	Cast iron	580	70	23.2	1.7	155	165	138	12.3	Baf.—In. gas
51	Su	22C	Cast iron	520	110	23.1	3.8	130	140	167	34.2	Baf.—In. gas—De. air
52	Am	90	Cast iron	430	90	22.9	5.6	120	135	127	20.5	Baf.—In. gas—De. air —De. dr.
53	Sr	A-24-460	Cast iron	550	150	23.9	5.4	150	150	217	21.7	Baf.—De. air
54	Sr	A-22-420	Cast iron	420	20	18.7	0.4	120	145	221	10.8	In. gas—De. dr.
55	G	961-C	Cast iron	490	130	22.0	4.5	120	120	154	22.7	Baf.—De. dr.
56	Pe	27-8-22	Cast iron	450	130	19.6	1.3	110	140	133	23.3	Baf.—In. gas—De. dr.
57	V	948	Cast iron	635	200	25.7	5.0	150	150	207	20.7	Baf.—Clo. damp.
58	DJ	2563	Cast iron	555	75	22.9	4.5	275	275	280	23.3	Baf.
59	Co	C-2429	Cast iron	445	65	18.4	1.4	115	115	137	8.8	Baf.
60	W	2239	Cast iron	570	170	24.6	2.7	170	170	116	7.8	Baf.
61	RB	1132X	Cast iron	465	65	24.9	2.4	120	120	141	21.2	De. dr.—De. air
62	B	403	Cast iron	530	60	22.4	2.4	145	145	250	16.0	De. dr.—De. air
63	WR	19	Steel	540	170	21.7	3.1	65	65	69	14.5	Rem. lin.
64	He	46	Steel	455	105	22.6	2.9	140	140	182	10.5	Rem. lin.
65	He	55	Steel	400	40	20.5	1.2	195	210	241	14.1	Rem. lin.—In. gas
66	He	51	Steel	550	140	24.4	4.1	173	173	235	20.8	Cha. bur.—Clo. damp. —De. dr.
67	Q	3-G	Steel	460	90	19.8	2.2	135	135	168	14.3	Rem. lin.
68	Q	1-B	Steel	450	150	20.9	4.3	120	120	126	9.6	Rem. lin.—Cha. bur.
69	Q	3-31	Steel	380	80	18.4	2.0	125	125	166	15.7	Rem. lin.—Cha. bur.

*Am—American; B—Baronet; Co—Coles; DJ—Detroit Jewel; G—Garland; He—Hess; Ho—Holland; Pe—Peninsular; Q—Quaker; RB—R & B Progressive; Su—Sunbeam; Sr—Superior; V—Vasco; W—Ward; WR—Waterbury Radio.

†Baf.—Baffled; Cha. bur.—Changed burner; Clo. damp.—Closed indirect damper; De. air—Decreased excess air; De. dr.—Decreased excessive draft; De. gas—Decreased gas rate; In. gas—Increase gas rate; Rem. lin.—Removed firebrick lining from firepot.

and transfer it to the heating medium.

10. Various combinations of the above phases.

In the vast majority of cases there is usually more than one of these features to be taken care of when the job has not been operating as it should. With each case it will be stated what was done to the job in order to rectify a previous undesirable condition which was responsible for either unsatisfactory operation or too high an operating cost, or both.

The cases cited in the Tables 1 and 2 will serve briefly to illustrate the importance of correct engineering as regards conversion burner installations. It especially points out the value of correctly engineering the job after the installation. It also illustrates how badly jobs can be out of line when they are carelessly engineered especially after the burner is installed. In some cases careless engineering prior to the installation was corrected later on with benefits as shown. The reductions in operating costs due to baffling, proper draft adjustment, minimum excess air and the use of the correct input of gas rate on the burner as determined by the heating test, illustrate the importance of these four major engineering steps. The other engineering steps mentioned earlier in the series are, in general, of lesser importance.

10% Saving Possible in Average Job

Some of the cases cited are extreme ones, but show what corrective engineering can do to a job. The majority of the cases are more or less average cases. It must be remembered, however, that all of the cases were "trouble" jobs and called for correction of conditions. In all cases unsatisfactory heating conditions were corrected and in most cases operating costs were reduced to that estimated or lower. It is the author's contention that in any territory where jobs are not engineered as outlined, out of every 100 jobs picked at random, improvements can be made by corrective engineering which will average 10% at least.

The tables are self-explanatory. In each case the engineering factor or factors responsible for the improvement of the job are stated. Their careful study will demonstrate what can be done to a "sick" job by corrective engineering. Needless to say it should be convincing argument that the engineering steps which will make a good job out of a bad one should be applied to every installation right after it is made so that only "healthy" jobs will be attached to the lines of the gas company.

Large reductions in flue temperature can be obtained by baffling boilers and furnaces with consequent reduction in flue loss. Considerable reduction in flue temperature can also be made by reducing strong draft conditions to an operating minimum. There is, naturally, a direct relation between flue temperature and flue loss, but there is no direct relation between either flue temperature or flue loss reduction and reduction in operating cost because of a change in any one of these three factors. Flue temperature and flue loss are concerned only with the boiler or furnace while operating cost depends on the thermal efficiency of space heating, of which the boiler or furnace efficiency is only a part. A whole series of efficiencies are involved, and boiler or furnace efficiency is only one of the series.

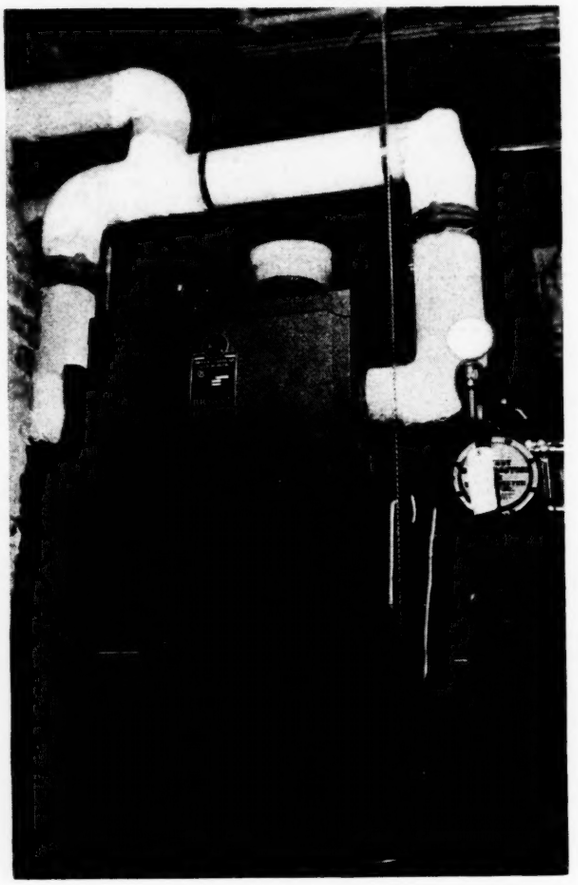
No attempt will be made within the scope of this article to go into a discussion of this matter and demonstrate the reasons why it is possible to obtain such results as shown in the tables. The author will discuss this matter in a special article in the near future.

Gas Heat Brings New Tenants to Loft Building

THE landlord of the five-story loft building at 818 Sixth Ave., New York, found renting conditions growing steadily worse last year until he modernized with gas heating. Tenants had vacated three floors because of the absence of central heating and because they could obtain satisfactory quarters in neighboring buildings at approximately the same rentals with the advantage of furnished heat. The shopkeepers on the first floor continued their stores despite the lack of central heating, but only two tenants remained on upper floors.

It was evident to the owners that heat must be supplied or the remaining tenants likely would vacate also. Consequently, gas fired steam heating was installed.

A one-pipe steam system was laid out and installed, a corner of the basement being partitioned off for the new boiler. A feature of the boiler room is the obvious intention of the owners as to fire protection. The boiler room has brick walls, cement floor, and a sheet metal ceiling, and contains no apparatus other than the boiler. The plant is vented into an existing brick chimney. Gas was selected primarily because of its anticipated safety as to fire, since the superintendent devotes practically all his time to another building in the neighborhood two blocks distant. Thus the heating plant in the loft building is without personal attention except a few hours daily.



The gas fired boiler used in the modernized five story loft building

Shortly after the modernization, early last winter, rentals were raised $5 monthly. Old tenants remained and one new tenant was acquired. It is expected by the agents that the improvement will result in complete occupancy this fall. The agents concede that without central heating the building probably would be untenanted.

Cleaning Air-Cooled Condensers

AN important service operation on refrigeration machines having air cooled condensers is to clean the exterior of the condenser.

Invariably a small amount of oil from the motor collects on the condenser fins. Dust particles from the air adhere to the fins, and, after awhile, the accumulation of dust becomes quite thick as a result of associating with the oil. This results in reduction of heat transfer due to restriction of the flow of air and the insulating effect of the dust.

For example, a decrease of air volume from 500 c.f.m. to 400 c.f.m. results in a decrease in condenser capacity of 13%. In addition, the insulating effect of the "fluffy" dust on the surface of the fins may result in a decrease in capacity of 20%. (In some cases the decrease in capacity may be as high as 90%.)

An increase in head pressure of 20 lb., due to the condenser being dirty, resulted in the capacity of a certain high-side decreasing from 2,395 B.t.u. per hr. to 2,015 B.t.u. per hr., or to 84% of its capacity. This may be very serious, resulting in longer operating time and increase in current consumption.

A simple method of cleaning a condenser on the job is to blow the dust through with an ordinary auto pump. This is much more preferable than a brush as it gets the dust out from *inside* of the condenser instead of forcing the dust *into* the inside portion of the condenser. Also it must be kept in mind that if the condenser happens to be a two pass, three pass, or greater, it cannot be cleaned with a brush at all and must be cleaned with a pump if a thorough job is desired.

The auto pump is easily available to anyone and cleaning may be done right on the job without moving the condensing unit. Use the pump with a quick downward motion, holding the end of the hose against the face of the condenser—*Fedders News.*

Convention and Show Draw Record Crowd

In spite of an opening day during which the temperature fell to 12 below zero; in spite of the crippled railroad service into Chicago with trains as much as five hours late, and in spite of the six miles separating the exposition from meeting headquarters at the Palmer House, the 42nd annual meeting of the American Society of Heating and Ventilating Engineers and the Fourth International Heating and Ventilating Exposition drew an attendance approaching closely to the all-time high record made at Philadelphia in 1930.

Final figures are not available as this is being written on the second day of the meeting and exposition, but with only slightly over one day gone the attendance had passed 850 with new arrivals coming so rapidly that the registration desk had lost count Three hundred exhibits, by far the largest of any of the four heating and ventilating shows yet held, were drawing large crowds from the time the doors opened at noon the first day. Elaborately designed and beautifully executed booths impressed even seasoned exhibit attenders.

The ASHVE meeting opened Monday at 10 a.m. in the Red Lacquer Room of the Palmer House, with greetings by President John Howatt. Following this the reports of the various committees were presented.

The Tuesday morning session was devoted to the presentation of three technical papers. A report entitled "Thermal Properties of Concrete Construction" gave the results of a study of different types of masonry and monolithic concrete constructions which was made with the purpose of determining methods of increasing the thermal resistance of such constructions. It is a well known fact that practically all materials having a high structural strength also have a high heat conductivity. This makes it necessary to employ some substance with a high thermal resistance in order to reduce the amount of heat transmitted through constructions using such materials. Concrete is one of these materials which, if used without some insulating substance, may have a prohibitive heat conductance.

There are several methods by which thermal resistance may be built into a concrete wall. First, the insulating value of an air space may be made use of. Second, a surface finish may be added which will reduce the normal air filtration through the wall. Third, some type of insulating material may be applied to the surface of the wall.

The first conclusion reached by the authors of this paper was that concrete of average aggregates has a conductivity value of between 12 and 13. The second conclusion was that lightweight aggregates are more effective in reducing the conductance of monolithic

Prof. G. L. Larson, newly-elected president of ASHVE.

walls than they are in reducing the conductance of masonry walls with cored out sections. It was found that the reduction in conductance of a masonry wall built of 12-in. hollow blocks over that of a similar wall built of 8-in. blocks was less than 15%, whereas for a monolithic wall the reduction was approximately 50%.

It was also found that a surface finish serves to reduce the infiltration of air, and therefore tends to reduce the thermal conductivity.

A. P. Kratz and S. Konzo of the University of Illinois presented a paper entitled "Fuel Saving Resulting from the Use of Storm Windows and Doors." The purpose of the paper was to determine, under actual conditions, the amount of fuel that could be saved by adding storm windows and doors to a typical residence, and to compare the actual saving with the saving computed from heat loss calculations. The research residence and heating plant in which these tests were conducted has a calculated heat loss of approximately 137,500 B.t.u. per hr. when the temperature differential is 70°, and approximately 159,000 B.t.u. per hr. with an 80° differential. The residence was occupied by four people. Some of the conclusions follow:

1. In a frame building similar to the research residence it is possible to reduce the fuel consumption by approximately 20% if storm windows and doors are used.

2. While a reasonable estimate can be made of the savings by computation, the saving indicated tends to be higher than that actually demonstrated by the test.

Recently the heat control industry has been paying a large amount of attention to thermostats employing some means of artificial heat within the thermostat itself Burton E Shaw, research chief, Penn Electric Switch Company, made tests on eight different thermostats with the object of studying the operating features. Certain thermostats were investigated more fully than others because of limited time and test facilities. Five of the thermostats tested were of artificially heated construction. The sixth was a standard precision construction conventional unit. The seventh was of the same construction except that it employed a clock used for set-back temperatures at night, and the eighth was a clock-actuated thermostat which operated at times to turn on the heating surface if any room temperature drop of a fractional degree occurred at the thermostat location. The purpose of the paper he presented before the convention was to correlate the results of these tests in order to compare the effect of thermostat design, operation, and location on various factors affecting oil consumption, flue gas loss, off-period stack loss, and physiological comfort. He also reported on the effect on oil consumption of lowering the thermostat setting during the night. He warned his listeners to bear in mind that the results reported are those accomplished only by this investigation, and may not generally apply to other installations.

The conclusions of the paper can be summarized as follows:

1. Practically no difference was found between economy of close temperature control and that obtainable with conventional wide temperature operation.

2. Close temperature control obtainable with either short or medium cycling was more desirable from the standpoint of comfort than conventional thermostat control with its greater temperature variation.

3. The shorter the cycle of operation, the lower the average flue loss. The reverse is true for the off-period loss. That is, the loss for short-cycle operation is greater than that for medium or long-cycle operation.

4. From the standpoint of human comfort it was found that 30-in. thermostat mounting gives much better results than the 5-ft. mounting. Practically no difference in economy was found between these mountings.

5. In the two installations in which there was a night set-back of approximately 6°, a fuel saving resulted, the amount depending on the thermostat operation and the degree-days. In general, savings were about 8 and 10%.

6. One of the most important conclusions to be drawn from this investigation relates to the inherent advantages of short as compared to long-cycle operation. Greater room comfort conditions resulted from short and medium cycles. If present designs permitted more complete control of off-period losses, short-cycle operation would give the ultimate in economy because of lower flue gas losses.

WHAT READERS SAY • • •

Infiltration

Can you give me the correct answer to the following?

Assuming a room has six windows, 36 in. wide, each window having a 1/16-in. opening at the meeting rails. Said room must be kept up to 70°, 24 hr. a day (such as in a hotel or hospital), and the outside average temperature about 40°. How much more coal would be required to keep this room warm due to infiltration than would be required if there were no leaks at the meeting rails? Figure the coal at 13,000 B.t.u. per lb. .....over a period of 90 days.

Cleveland, Ohio. **J. E. M.**

The solution to your problem depends considerably on how the windows are arranged in the room. Customarily, only the windows on one side are taken into account, as the air is leaving through the other side. We are giving two solutions to this problem. One is where we assume that there are three windows in each wall, and the second is where we assume that there are four on one side and two on another. If the window arrangement is other than these two, the unit figures are given in the solution and you can make your own calculations rapidly enough.

Problem—Average wind velocity in Cleveland, December, January, February—14.5 S.W. (from HEATING & VENTILATING's Reference Data Sheet No. 58). Air infiltration of 40 cu. ft. per hr. per ft. at 15 m.p.h. (from HEATING & VENTILATING's Reference Data Sheet No. 59, Table 1, Column 7).

Solution 1—Three windows in each wall

3 ft. of meeting rail in each window — 3 × 3 windows = 9 ft.

9 ft. × 40 cu. ft. per ft. per hr. = 360 cu. ft. per hr.

Heat required to warm 360 cu. ft. from 40 to 70 is found as follows:

360 cu. ft. × 30° × 0.018 B.t.u. (to raise 1 cu. ft. through 1°) = 195 B.t.u. Therefore, 195 B.t.u. per hr. needed.

195 × 24 = 4680 B.t.u. per day

4680 × 90 = 421,200 B.t.u. in 90 days

$\frac{421{,}200}{13{,}000}$ = 32.4 lb. coal at 100% efficiency, or 64.8 at 50% efficiency

Solution 2—Four windows on windward side, two on the other

3 × 4 × 40 = 480 cu. ft. per hr.

480 × 30° × 0.018 = 258.0 B.t.u. per hr.

$\frac{258 \times 24 \times 90}{13{,}000}$ = 43.2 lb. coal at 100% efficiency, or 86.4 lb. at 50% efficiency.

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Stoker Bibliography

As a user of two commercial and one domestic stokers I feel that I would like to know more about this equipment. Would you be so kind as to suggest to me a bibliography covering the following items in which I am interested:

1—Theory of design and operation, materials of manufacture.

2—Practical operation and adjustment for various conditions of installation.

3—Installation instructions for best efficiency and satisfaction of operation.

4—Stoker fuels with best information on how to adjust for burning the various kinds.

5—Stoker automatic controls.....

Raleigh, N. C. **C. R. P.**

.....herewith a selected bibliography..... (in the following the numbers preceding the title of the article indicate the classification(s) under which that article falls):

2, 3, 4—*Notes on Underfeed Stoker Operation*, W. M. Parks, HEATING & VENTILATING, page 55, August, 1935.

2, 3—*Application of Coal Stokers to Baker's Ovens*, David Landau, HEATING & VENTILATING, page 23, December, 1934.

2, 3, 4—*Coal Selection, Capacity Checking, and Installation Hints for Small Heating Stokers*, David Landau, HEATING & VENTILATING, page 46, October, 1934.

1, 3—*Modern Unit Stokers for Heating*, HEATING & VENTILATING, page 29, September, 1934.

1, 5—*Reference List—Heating Stokers*, HEATING & VENTILATING, page 18, August, 1934.

1, 5—*Mechanical Features of Modern Stokers for Automatic Heating*, HEATING & VENTILATING, page 17, August, 1934.

2, 3—*Setting Heights for Stoker-Fired Boilers*, HEATING & VENTILATING, page 72, July, 1931.

2, 3—*Some Observations on the Performance of Stokers in Firebox Boilers*, C. E. Bronson, presented at 2nd Midwest Bituminous Coal Conference, University of Illinois, May 21, 1931. Abstracted, HEATING & VENTILATING, page 93, July, 1931.

4—*Fuel Section and Automatic Stoking in Heating Plants*, J. Harrington, HEATING & VENTILATING, page 114, December, 1930.

4—*Factors in the Selection of Coal for Underfeed Stokers*, presented at annual meeting of ASME, December 5, 1935, COAL HEAT, page 18, December, 1935.

3—*Safe Furnace Proportions Prevent Smoke with Underfeed Stokers*, POWER, page 596, November, 1935.

4—*Adaptability of Various Coals for Use with Stokers*, George G. Ritchie, COAL-HEAT, page 10, March, 1935.

2, 3, 4, 5—*Automatic Coal Heat with Mechanical Stokers*, published by Committee of Ten, Coal & Heating Industries, 307 N. Michigan Ave., Chicago, price 25c.

1—*Domestic Burners for Pennsylvania Anthracite*, Commercial Standard CS48-34, Superintendent of Documents, Washington, D. C., price 5c.

1—*Underfeed Combustion*. Bulletin 378, Bureau of Mines, U. S. Department of Interior, Superintendent of Documents, Washington, D. C., price 10c.

2, 3—*Effect of Setting Heights on Efficiency and Output of Stokers*, Report L-2057, Anthracite Institute, Primos, Delaware Co., Pa.

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Effective Temperature

Referring to the study "Effective Temperatures as an Index of Air Conditioning Need," by J. E. Hitlin and G. W. Hart, published in HEATING & VENTILATING, December, 1935, I should be greatly interested to know the reason why the scales of dry bulb temperature and "effective" temperature are different on the chart, presented in this study .....

Vienna. **H. L.**

.....regarding our article in the December, 1935, issue.....In our chart, we superimposed the three independent curves for the sake of convenience in translating any specific "effective temperature" value into the component dry bulb temperature and relative humidity readings from which it was derived. We had no specific reason in mind for establishing the scales in any position with respect to each other. Our chart was designed simply to indicate comparative severity of weather conditions by reference to an effective temperature scale, upon which we spotted the comfort zone limits as defined between 69° and 73° "effective temperature."

J. E. HITLIN

Long Island City. G. W. HART

Heat Loss Tables

Can you tell me where I can find tables of B.t.u. heat loss coefficient for computing radiation?

Oswego, N. Y. K. C. B.

Complete tables on heat loss coefficients have been prepared and will appear during the next few months in HEATING & VENTILATING. The first of these are found in the article "Getting Down to Fundamentals" in this issue.

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Utica Degree-Days

I am enclosing two curves made up from our degree-day records that present an interesting method of studying fuel requirements.

1.—"Fuel Use by Months" (Fig. 1) shows graphically the per cent of fuel used by months based on degree-days in this area. We have furnished copies of this to fuel dealers locally with the idea in mind that a customer who complains in December or January "I am burning too much fuel—it's no good," can be shown in a graphic way that fuel consumption is high in certain months.

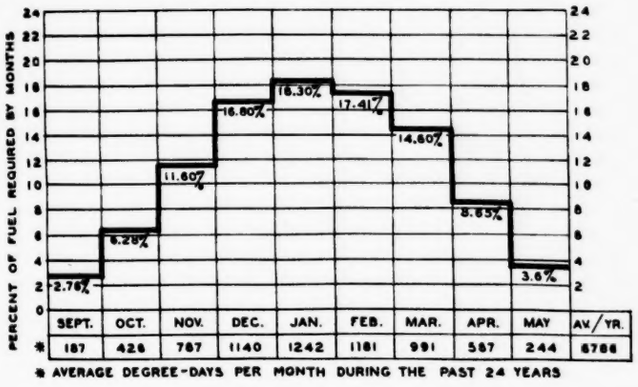

Fig. 1. Per cent of total season's fuel supply used each month in Utica, N. Y., and vicinity.

2.—"Coke Use Indicator" (Fig. 2) is another way of setting up our degree-days. We accumulated the average per cent of degree-days by months for the nine months

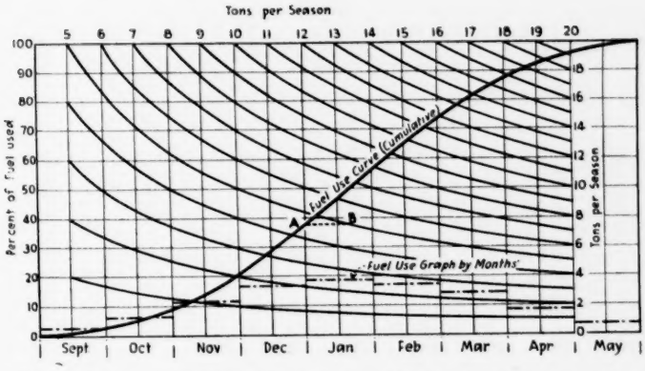

Fig. 2. Coke use indicator used to estimate fuel consumption.

(September through May)—drew a smooth curve through them and so developed the "fuel use curve." (This was made up five years ago, using 20 years of degree-days). Of course, wind velocity is not considered. To check this chart we approximated the fuel use (Niagara Hudson Coke) every two weeks in each of 10 Utica homes and then checked it against our "fuel use curve." We found that the per cent of fuel used each month as a part of the total for the fuel burned for the nine months was remarkably close to this curve.

Often coke customers come in who live in average houses and say "we have burned so many tons of coke since September 1—how much more do you think we will need?" We can approximate from this curve the additional amount that they would need based on average weather.

Any architect, engineer, or fuel dealer could build these curves in a similar way for his own community. We use these graphs constantly in the sales of coke or gas for home-heating. We know definitely that our sales of coke or gas for home-heating vary directly with the degree-days in any month and so watch our degrees each month as reported. For example, the degree-days for December, 1935, were 1,358—that shows the coldest December since December, 1910, on the chart mailed to you (Table 1).

These data are sent as an offering toward the constructive use of degree-days by heating men in their own communities .....

R. C. EDMUNDS,
Manager Coke Sales
Utica, N. Y. Utica Gas & Electric Company.

TABLE 1.—DEGREE-DAYS FOR UTICA

YEAR	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	JANUARY	FEBRUARY	MARCH	APRIL	MAY	TOTAL
1910-11	236	434	870	1,364	1,147	1,064	1,116	690	31	6,952
1911-12	275	496	900	992	1,550	1,260	1,116	630	248	7,467
1912-13	258	341	630	899	930	1,148	806	420	217	5,649
1913-14	195	279	630	930	1,209	1,372	1,023	630	93	6,361
1914-15	192	310	1,020	1,240	1,209	1,036	992	330	310	6,639
1915-16	227	372	750	1,147	1,116	1,334	1,240	570	248	7,004
1916-17	230	434	840	1,170	1,333	1,288	1,054	690	496	7,535
1917-18	94	589	930	1,457	1,488	1,120	868	510	31	7,087
1918-19	295	248	630	992	1,044	952	899	540	155	5,755
1919-20	94	310	720	1,240	1,457	1,131	868	600	155	6,575
1920-21	100	186	750	992	1,116	952	651	330	124	5,201
1921-22	66	434	810	1,170	1,457	1,131	899	570	93	6,630
1922-23	99	465	750	992	1,364	1,288	1,116	570	248	6,892
1923-24	140	465	750	992	930	1,334	992	630	403	6,636
1924-25	290	465	780	1,271	1,426	980	868	570	385	7,035
1925-26	262	642	791	1,099	1,221	1,171	1,120	699	275	7,280
1926-27	302	488	730	1,252	1,241	1,023	870	618	322	6,846
1927-28	130	413	714	1,184	1,269	1,261	1,099	727	328	7,125
1928-29	231	440	812	1,074	1,356	1,266	867	601	344	6,991
1929-30	144	563	803	1,250	1,309	1,183	1,060	688	345	7,345
1930-31	199	507	761	1,212	1,392	1,251	915	588	282	7,107
1931-32	111	416	584	1,083	975	1,146	1,164	736	292	6,507
1932-33	184	400	920	1,062	1,062	1,115	1,087	588	220	6,638
1933-34	131	522	1,018	1,304	1,212	1,540	1,101	572	217	7,617
1934-35	61	542	644	1,229	1,410	1,171	941	611	462	7,071
TOTAL (25 yrs.)	4,546	10,761	19,537	28,597	31,223	29,517	24,732	14,708	6,324	169,945
AVERAGE	182	430	781	1,144	1,248	1,181	989	588	253	6,796
% OF TOTAL..	2.69	6.18	11.5	16.83	18.4	17.4	14.6	8.65	3.75	100.00

EDITORIALS

Follow Apartment House Work

Last year we predicted that much modernizing work would be found in apartment houses. It now develops that the prediction was fully borne out. At that time we called attention to the favorable factors which led to the conclusion that apartment house owners would be active. These factors included increased occupancy, better collections, and indications that rental rates would be increased. Now these factors are even more marked than they were then. Recent surveys show average apartment house occupancies of 94%, with some cities reporting all such space rented 100%. Nearly $100,000,000 worth of new apartment houses were built in 1935 and the increased percentages of occupancy are in the face of this new construction. In other words, even though there was active construction it did not catch up with the demand.

Now we predict that 1936 will see both modernizing and new construction of apartment houses go forward to an extent that will surprise those who aren't watching developments closely. So much attention has been given to attempts to develop new and cheaper detached houses, especially those of the prefabricated type, that attention has been drawn away from the progress made in furnishing satisfactory housing in multiple-units under one roof. Again we say, keep up to date on the apartment house situation. There are opportunities there.

Keep the Meaning Clear

The words "housing" and "residential" are often seen in the press these days. Both seem respectable enough but both are in way of being over-publicized and misinterpreted. Don't be misled by the meanings now being attached to them.

Just now the word "housing" is being twisted to mean "houses." Now as a matter of fact, the word housing really means something akin to shelter, and shelters include all kinds of places where people live—tenements, shacks, tents, igloos, sodhouses, detached frame and masonry houses, two-family houses, apartment houses, hotels, clubs, and palaces. When housing is mentioned you should be sure to find out whether it is used in its broad or its narrow meaning before jumping at conclusions.

Much the same is true of "residential," for it is being interpreted to mean "residences" in the sense of one and two-family residences. As a matter of fact, no such restriction of meaning is justifiable. Yet the newspaper press especially implies this meaning persistently, and unless you are wary you will be led into wholly erroneous impressions. Unfortunately, equally indefinite and misleading impressions can be obtained if the word is applied too broadly. So long as this situation persists we believe that the word should be looked on with suspicion.

We also believe that the usefulness of both words will disappear entirely unless their meanings become more specific.

What does it mean, for instance, to read that "residential construction in 1935 was double its volume in 1934" unless we know something more about the individual increases that went to make this overall statement correct? As it stands, the statement not only conveys little, but is currently being taken to mean that the construction of detached residences doubled in 1935. Nothing is included to indicate that the reported construction of new apartment houses increased 235%, or that housing developments increased 260%. Neither does the statement as it stands take note of the fact that one and two-family dwellings accounted for but 60% of the total "residential" new construction while multi-family accommodations accounted for the other 40%. Neither does the statement disclose that of all the reported new building construction in 1935, only about 25% was done in one and two-family houses.

Suppose you were to take all the ballyhoo about housing and its future problems and promise too much to heart at present, and at the same time were to accept the implication placed on statistical reports on "residential" construction. It is quite possible that you would be misled into believing that the bulk of the business and the interest is in catering to the market represented by the one- and two-family residence. If you did you would be concentrating on one-fourth of the volume and turning your back on three-quarters of it

Control is the Thing Today

Operating control is the central consideration in today's heating, ventilating, and air conditioning plants, having gradually eclipsed the peak capacity consideration. It used to be that if a plant could be put in to meet a guarantee which called for "70° at zero outside" that was all that was asked for. The purchaser was often secretly pleased if he would get a dependable guarantee in such terms. If he could just be assured that the plant wouldn't fail him on the worst day—that was all that could be expected.

Now what do we find? Well, the best specifications certainly are not limiting their requirements to a capacity statement, which is merely one of the things wanted. Now the informed purchaser wants to know whether the plant is going to maintain the inside temperature at all outside temperatures as well as at zero degrees. He is showing increasing signs of interest in relative fuel costs to get this done. Operating control is and ought to be recognized as an integral part of design, and equipment to accomplish suitable control in operation is coming to get consideration at the same time when systems are being selected and heating surface is being sized. We confidently believe that the time will come when the capacity-at-peak statement will disappear altogether as capacity will be a sort of tacitly understood minimum requirement, just as the ability of a motor car to take all ordinary hills on high is now assumed without argument. Plants will be judged on their day-to-day performance operating under suitable control, and not on their ability to get by the peak.

ABSTRACTS of Current Papers, Books and Pamphlets

Industrial Dust

It is only in the past few years that the subject of the health of workers in dusty trades has been receiving the attention that it deserves. The importance of this subject can be realized when it is known that the workmen employed in the dusty trades comprise the largest group exposed to any one industrial hazard.

The purpose of this bulletin is to present the methods and instruments used in conducting dust studies in industry, the manner of interpreting the results of such studies, and their practical applications to industrial problems, especially those phases dealing with the control of the dust hazard. The material in this bulletin is based largely on the practical experience gained by the authors in engineering studies of the dust problem in numerous industries in the United States.

[*"The Determination and Control of Industrial Dust," by J. J. Bloomfield and J. M. Dallavalle, U. S. Treasury Department, Public Health Bulletin No. 217. Paper bound; 6 x 9 in.; 167 pages. For sale by the Superintendent of Documents, Washington, D. C. Price 15c.*]

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Boiler Reference Book

The 1936 edition of the Pape-Swift boiler reference book has just been published. This book contains data on many obsolete and discontinued types of boilers, along with specifications of boilers of many manufacturers whose products were not listed in either the 1934 or 1935 edition. The three editions of this book furnish information on practically any type of heating boiler in use in the United States.

To make it possible to quickly locate information on any particular boiler, a master index has also been published. The index really transforms the Pape-Swift books into a boiler reference system, and should prove to be a great time saver to anyone requiring boiler information.

[*"The Pape-Swift Boiler Reference Book—1936 Edition," published by John S. Swift Co., Inc., 105 South Ninth St., St. Louis, Mo. Paper bound; 5¼ x 8¼ in.; 324 pages. Price $1 plus 10c for postage. Master Index furnished free with each order.*]

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1936 ASHVE Guide

In the 14th edition of the *Guide* a large amount of new and revised authoritative engineering data has been assembled from a variety of sources on the subjects of heating, ventilating, and air conditioning increasing the contents of the technical data section to 792 pages. The engineers and technicians who compiled this new volume have included in it the latest researches of the ASHVE Laboratory and cooperating institutions.

Four new chapters have been added to fulfill the requests for more detailed information on the subjects of refrigeration, drying, electric motors, and railway air conditioning. Included in the chapter on refrigeration are descriptions of the various theoretical and practical cycles with illustrated diagrams and thermodynamic tables of the most common refrigerants. Special consideration is also given to absorption, adsorption, steam ejector and reverse cycle systems of refrigeration. The chapter on railway air conditioning discusses the most recent trends in passenger car installations. Curves and tables showing the costs per car mile for various types of cooling systems are given with cost equations which take into consideration the various mechanical efficiencies applicable to tractive power.

Another feature is the new table of saturated water vapor extending over a range from 130° to + 200° with heat content values based on the varying values of specific heat for air.

In addition to the new material, the other chapters have been carefully checked and reviewed and in some cases the text has been completely rewritten so as to conform to more recent engineering practices. All of the information on unit heaters, ventilators, coolers and air conditioners has been correlated in one chapter with several additional sketches to illustrate the units now available. System characteristics of fans with curves to illustrate the effects of speed or system changes on fan operation have been added.

[*"The American Society of Heating and Ventilating Engineers Guide—1936," published by the American Society of Heating and Ventilating Engineers, 51 Madison Ave., New York. Flexible binding; 6 x 9 in.; 792 pages in technical section and 254 in catalog section. Price $5.*]

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A Heat Insulated Greenhouse

Last year a radical departure from common practice in heating greenhouses was tried out at the Boyce Thompson Institute of Plant Research at Yonkers, N. Y. A greenhouse was constructed having its sides, ends, floor, and half of the roof made of heat insulating materials entirely opaque to light. A single row of sash on one side of the roof was made of large panes of glass 24 in. wide and 32 in. long. In order to admit the maximum amount of light during the winter months when sun intensities are lowest, the sash was set at an angle of 52½ degrees to the horizontal. This setting places the glass in a position normal to the sun's rays at noon on November 5 and February 5.

The house was equipped with 300-watt lamps and the heat from these lamps was the only heating used in the house aside from the radiant energy of the sun. The lamps were controlled by a thermostat set to maintain the temperature between 62° and 68°. Under these conditions even in zero weather the lamps never burned when the sun was shining. On dark gloomy days the lamps burned occasionally. During the night with zero weather outside, the lamps came on about every half hour and burned for about 10 minutes. In general the total lighted period was about four hours in each 24. This happens to be just the right amount of supplemental lighting to be of greatest benefit to the plants.

Various flowers were raised in this house in comparison with similar plants raised in conventional all-glass type of greenhouse. The plants in the heat-insulated house grew larger and faster than in the conventional house Snapdragons, for example, bloomed eight weeks earlier.

[*"A Heat Insulated Greenhouse," by Lawrence C. Porter. Published in "Agricultural Engineering," December, 1935, page 487. Approximately 600 words, illustrations.*]

NEWS OF THE MONTH

General Motors Merges Its A.C. Companies

DAYTON, OHIO—General Motors Corporation has organized a new company for the marketing of year 'round air conditioning and automatic heating products.

The new company will be known as Delco-Frigidaire Conditioning Corporation. Its general headquarters will be in this city and sales headquarters for all eastern states will be located in New York City.

Organization of Delco-Frigidaire Conditioning Corporation will place under one direction the marketing of summer air conditioning equipment manufactured by Frigidaire Division and of winter air conditioning and automatic heating equipment manufactured by Delco Appliance Division. Manufacturing of the different types of air conditioning products will remain with Frigidaire and Delco Appliance Divisions at their plants in Dayton, Ohio, and Rochester, N. Y.

Contractors to Meet in Philadelphia

NEW YORK—The Heating, Piping and Air Conditioning Contractors National Association will hold its 47th annual convention in Philadelphia May 25-27, with headquarters at the Bellevue-Stratford. A program with addresses by authorities on their respective subjects and reports of officers and committees is being planned by the convention committee consisting of M. J. Chagnard, chairman, J. M. Anderson, J. C. Fitts, W. J. Olvany, and E. W. Tompkins.

The local convention committee, headed by J. M. Anderson, is making plans for the entertainment of members and guests.

A.C. for Capitol Building

CHARLESTON, W. VA.—Part of the new $10 million West Virginia State Capitol Building recently was equipped with Kelvinator year 'round air conditioning. With the idea of installing air conditioning for the entire building some time in the future, the State Legislature authorized air conditioning for the Governor's office and reception rooms, as well as the Museum and archives room. The equipment installed includes two suspended type air conditioning units and two 3-hp., water cooled, condensing units. The installation is of the ceiling unit type with central station system and concealed grilles.

The building has outside walls of masonry, 40 in. thick, and various ducts and fluted walls allow ready installation.

Gas Heat Used by 16% of Denver Homes

DENVER—A door-to-door campaign by 45 salesmen of the Public Service Company of Colorado, a subsidiary of Cities Service, has been producing remarkable results, according to figures just released by officials of that company. Between September 1 and the first of the year, 657 new gas heating units were installed in Denver homes, bringing the point of saturation in the use of that fuel as a heating commodity in the city to 16%. That is, one in every six homes now uses gas for heating.

Although these salesmen are primarily out to sell the public on the use of gas as a heating fuel, they are also expounding the comforts and advantages of air conditioning, still comparatively new in this region. It was only three years ago that the Public Service Company made its first installation of an air conditioning system in a private residence here. Of the 36 units this company has installed in private homes since, 15 were put in service during the last year.

N. Y. Schedules Home Show

NEW YORK — The National Home Show and Building Exposition will be held in the Port of Authority Commerce Building here March 23-April 4. The show is sponsored by New York City Better Housing Committee of FHA, of which Arthur R. Herske, vice-president of American Radiator Company, is chairman, and by the Rehabilitation and Modernization Association, Inc. A. S. Armagnac, formerly editor of HEATING & VENTILATING, is a member of the executive staff in charge of the heating and ventilating section.

The purpose of the show is to promote rehabilitation, modernization, industrial and home construction.

A.C. Bureau Elects

BOSTON—At the annual meeting and monthly dinner of the Air Conditioning Bureau of Boston, January 22, held at the Hotel Westminster, the following officers were elected for 1936:

President, Julius Daniels; vice-president, W. D. Wilkinson; treasurer, Rudolph Sommers; secretary, Daniel Ricker. Two new directors were elected for the three-year term—Lou Davis and R. V. Dunne.

New OBI Members

NEW YORK — Oil Burner Institute membership continues to increase. New members include: Sherwood Brothers, Inc., Baltimore, and Webster Electric Co., Racine, Wis.

Midwest Power Show Scheduled

CHICAGO—Features of interest to the power industry are being incorporated in the programs of the Midwest Power Engineering Conference and Engineering and Power Exposition to be held here April 20-24, according to a joint announcement by Frank D. Chase, president of the conference, and George E. Pfisterer, manager of the exposition.

Engineers of national prominence will appear at the conference sessions to be held in the Palmer House in the morning and at the International Amphitheater in the afternoon. The exposition will be held at the Amphitheater.

Among the conference sessions already organized are those on power economics, coal, refrigeration, and power transmission. One of the papers at the power economics session will be on "Trends in Power Research," by C. F. Hirshfeld, Detroit Edison Company. The coal session will include such topics as "Use Value," "Equipment," "Simplification," "Fuel Economy," and "Coordination of Controls." Joseph Harrington, Chicago engineer, will present a paper on "Simplification of Coal Sizing."

Insulation and refrigerants will be among the topics at the session on refrigeration. L. S. Morse, president of the ASRE will discuss "Power Used in Air Conditioning."

Railroads to Study A. C.

NEW YORK—With a view to determining what improvements, if any, can be made in air conditioning systems now in use, which ones are most suitable for railroad use, and to what extent they can be standardized so as to reduce the costs of installation and maintenance, a thorough study of the subject is to be made by the Association of American Railroads. The study will be conducted under the direction of L. W. Wallace, director of the equipment research division of the association.

It is the purpose of this study to determine the relative efficiency and economy of the various types and whether the air conditions being obtained in the cars are satisfactory from the standpoint of the comfort and well-being of the passengers.

Oil Up in Jersey

NEWARK, N. J.—Effective December 2, tank car price of Essoheat No. 2 and No. 4 fuel oil was raised ¼ cent per gal. in New Jersey at those points where the price was 6 cents or less. This change is chiefly effective in the Newark area where the price was increased from 6 to 6¼ cents per gal.

Birmingham Sets 1936 A.C. Quota

BIRMINGHAM, ALA.—The 1936 selling season was launched by members of the Air Conditioning Bureau of Birmingham at a luncheon January 14 followed by an inspection of the installation in the new $1¼ million department store of Loveman, Joseph & Loeb.

Estimates of the Bureau compiled by Leo M. Fried, engineer, are that 24 installations totaling $175,000 worth of equipment should be made in Birmingham in 1936. This compares with 22 installations totaling 646 tons last year. The tonnage this year is not expected to be quite so great on account of the size (350 tons) of the Loveman, Joseph & Loeb job last year.

The Birmingham Electric Company has announced it will cooperate fully with the dealers, making no air conditioning sales itself. The sales floor and windows will be loaned for display of equipment, the sales engineer will assist in making up estimates, and the 10 commercial salesmen and 45 residential salesmen for the company will turn over the names of prospects to the dealers. A program of direct mail and newspaper advertising is also being drawn.

The utility will also assist dealers in the sale of attic fans and commercial ventilation, estimates being that 50 attic fans at an average price of $200 each and $20,000 worth of commercial ventilation will be sold during the year. Arrangements have been made to use 15 attic fan installations in various parts of the city for demonstration purposes.

Wood Refuse Burned by Heating Plant

SPOKANE—The Central Heating Company of Spokane used in 1935 large quantities of waste refuse from surrounding sawmills and planing mills for evaporating into steam 362,752,810 lb. of water. In addition to other forms of waste fuel, or burnable material salvaged for heat, this district heating utility used 16,603 cords of lumber mill refuse, company statistics for the year show.

Boston Group Elects

BOSTON—Officers for 1936 were elected by the Boston Oil Burner Associates January 14, as follows: president, Harry E. Mayo; vice-president, T. E. Shepherd; secretary, Fred E. Beckwith; directors, with the above, James Kelly, Jr., and Kai Layborne.

Frederic V. Bell, U. S. Gypsum Company, was the speaker of the evening, and gave a talk on rockwool insulation. He said that his company had produced 24 million sq. ft. of this material in 1935 and that the output would be doubled by July 1.

COMING EVENTS

FEBRUARY 13-14, 1936. *Second Annual Welding Conference, Texas Technological College, Lubbock, Tex.*

APRIL 6-11, 1936. *Southern Industrial Show, Textile Hall, Greenville, S. Car.*

APRIL 14-18, 1936. *Twelfth National Oil Burner Show, Convention Hall, Detroit, Mich.*

APRIL 20-24, 1936. *Midwest Power Engineering Conference (Palmer House) and Engineering and Power Exposition (International Amphitheater), Chicago, Ill.*

MAY 25-27, 1936. *Forty-Seventh Annual Convention of Heating, Piping and Air Conditioning Contractors National Association, Bellevue-Stratford Hotel, Philadelphia, Pa.*

JUNE 9-11, 1936. *Short Course in Coal Utilization, Department of Mining and Metallurgical Engineering, University of Illinois, Urbana, Ill.*

JUNE 16-19, 1936. *National District Heating Association Convention and Exhibit, Pantlind Hotel, Grand Rapids, Mich.*

JUNE 22-24, 1936. *Semi-Annual Meeting American Society of Heating and Ventilating Engineers and American Society of Refrigerating Engineers (Joint Meeting), Buck Hill Falls, Pa.*

Stoker Symposium Sponsored by Coal Company

CINCINNATI—With over 75 representatives of coal companies, research agencies, and stoker manufacturers present from 27 cities, a symposium on stokers, sponsored by Appalachian Coals, Inc., was held here January 6 at the Queen City Club. Prominent engineering authorities were on hand to hear J. F. Barkley, supervising engineer, U. S. Bureau of Mines, discuss "Coal Selection and Burning in Government-Owned Plants"; R. A. Sherman, Battelle Memorial Institute, Columbus, tell of the "Preliminary Findings in the Program of Bituminous Coal Research, Inc.," and to take part in the symposium which was designed to correlate development and research efforts that ultimately will help to increase satisfaction from the use of household stokers.

A.C. Course at Columbia

NEW YORK—A night course in air conditioning covering the period from February 5 to May 20 on Wednesday and Friday evenings is being given by the University Extension Division of Columbia University. The course is in charge of John Everetts, Jr.

Chemical Men Discuss Heat Transmission

NEW HAVEN, CONN.—Advances in heat transmission affecting the industries, the home, and aeronautics were disclosed at a symposium of the division of industrial and engineering chemistry of the American Chemical Society, held at Yale University December 31, 1935, and attended by scientists, engineers, and industrialists from all over the country.

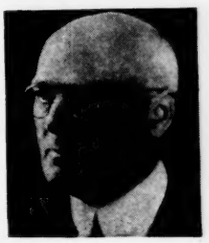
Prof. L. Washington, of Leland Stanford University, and M. Marks, of the Standard Oil Company of California, presented new data on the heating and cooling of air which, it was declared, will find many applications in the chemical industry, in power plant engineering, and in airplane engine design.

Prof. G. H. Montillon and D. F. Jurgensen, Jr., of the University of Minnesota, showed that the very simple factor of the angle of tubes in a condenser has an important bearing on the condensing capacity. This development, it was said, will influence the future design of equipment used in a wide variety of industries.

Other papers set forth new data of aid to the designer of condensers, evaporators, and heat exchangers which are used in numerous industrial fields, including petroleum refining, salt manufacture, sugar refining, power plants, and gas manufacture.

Fred R. Low

PASSAIC, N. J.—Fred R. Low, nationally known engineer and journalist, died January 22 at his home here. He had been critically ill for several years.



At the time of his death, Mr. Low was editor emeritus of the engineering magazine *Power* following 42 years as its chief editor. One of his greatest accomplishments was the work he did in connection with the codification of safety rules for the construction of steam boilers. He was a past president of the ASME and former mayor of this city.

Mr. Low was born in 1860 in Chelsea, Mass. In 1888 he left the *Journal of Commerce* to become the fifth editor of *Power*, which had been founded four years earlier, and continued in this position until 1930.

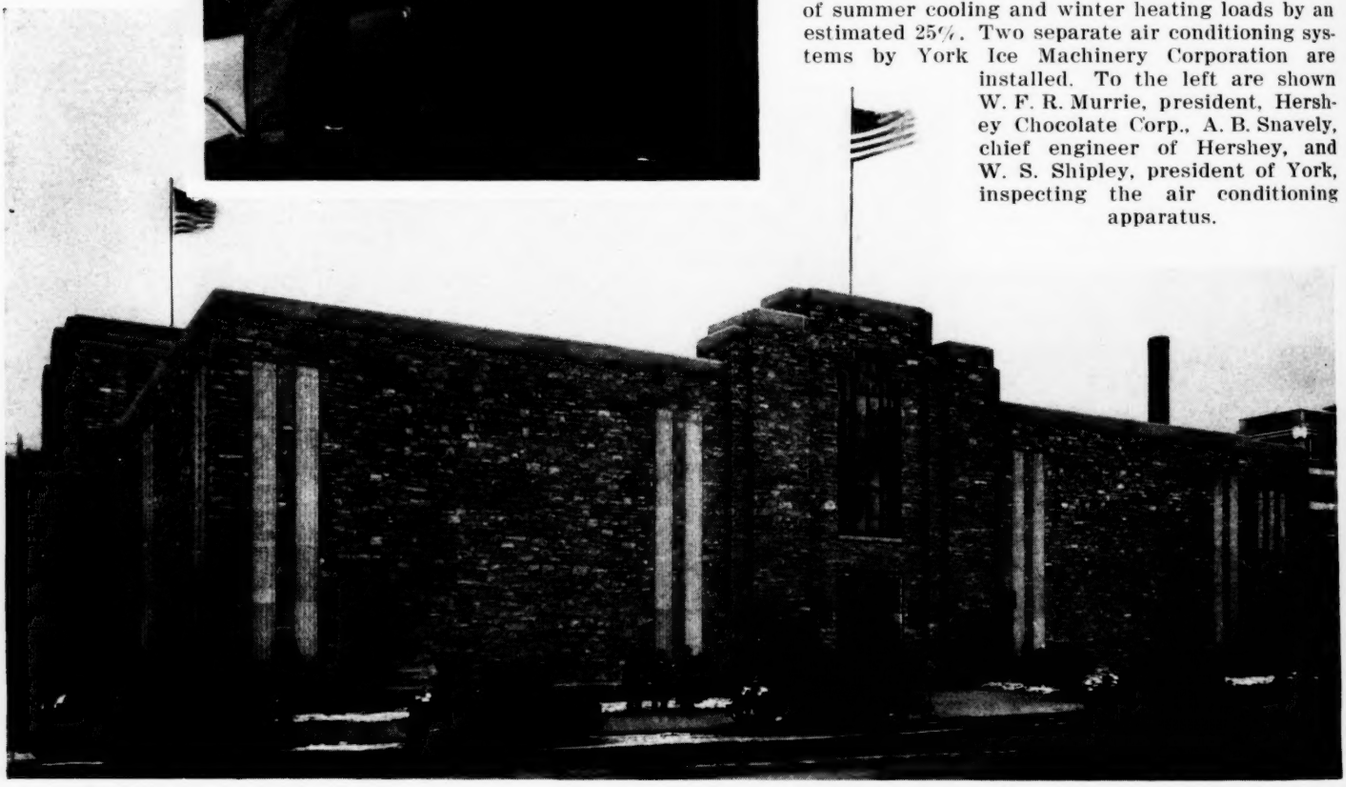
He is survived by his wife, a sister, four children, 14 grandchildren, and two great-grandchildren.

Francis Howard Mason

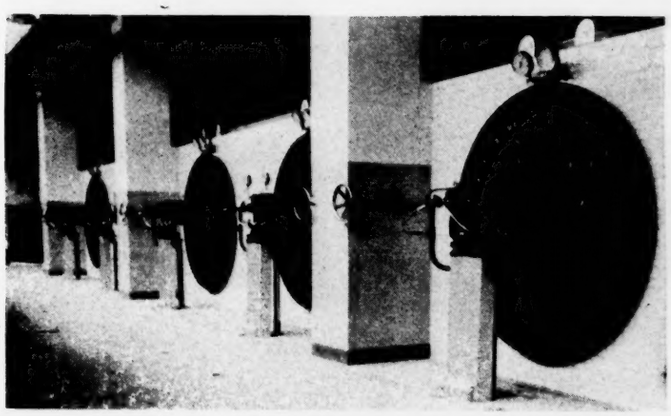
LOUISVILLE, KY.—Francis Howard Mason, manager of the furnace filter division of American Air Filter Company, Inc., died December 25, 1935.

PICTURE

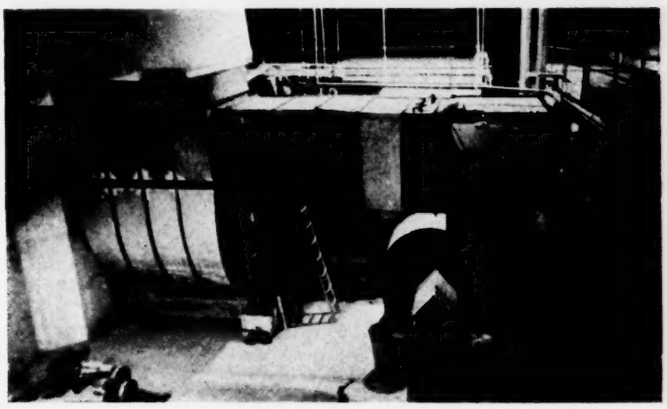
WINDOWLESS OFFICE BUILDING. (Below). Hershey Chocolate Corporation's new office building, opened December 28. Insulation and elimination of heat loss through windows reduced the total of summer cooling and winter heating loads by an estimated 25%. Two separate air conditioning systems by York Ice Machinery Corporation are installed. To the left are shown W. F. R. Murrie, president, Hershey Chocolate Corp., A. B. Snavely, chief engineer of Hershey, and W. S. Shipley, president of York, inspecting the air conditioning apparatus.



REFRIGERATION IN PERSIAN DESERT. (Left). High mud walls on the south and west protect these conical mud refrigerators. A hole 30-ft. deep equal in diameter to the cone top is dug underneath. Here ice from the mountains is placed during the winter months and covered with earth for use during the hot summer. Photo by Ewing Galloway.

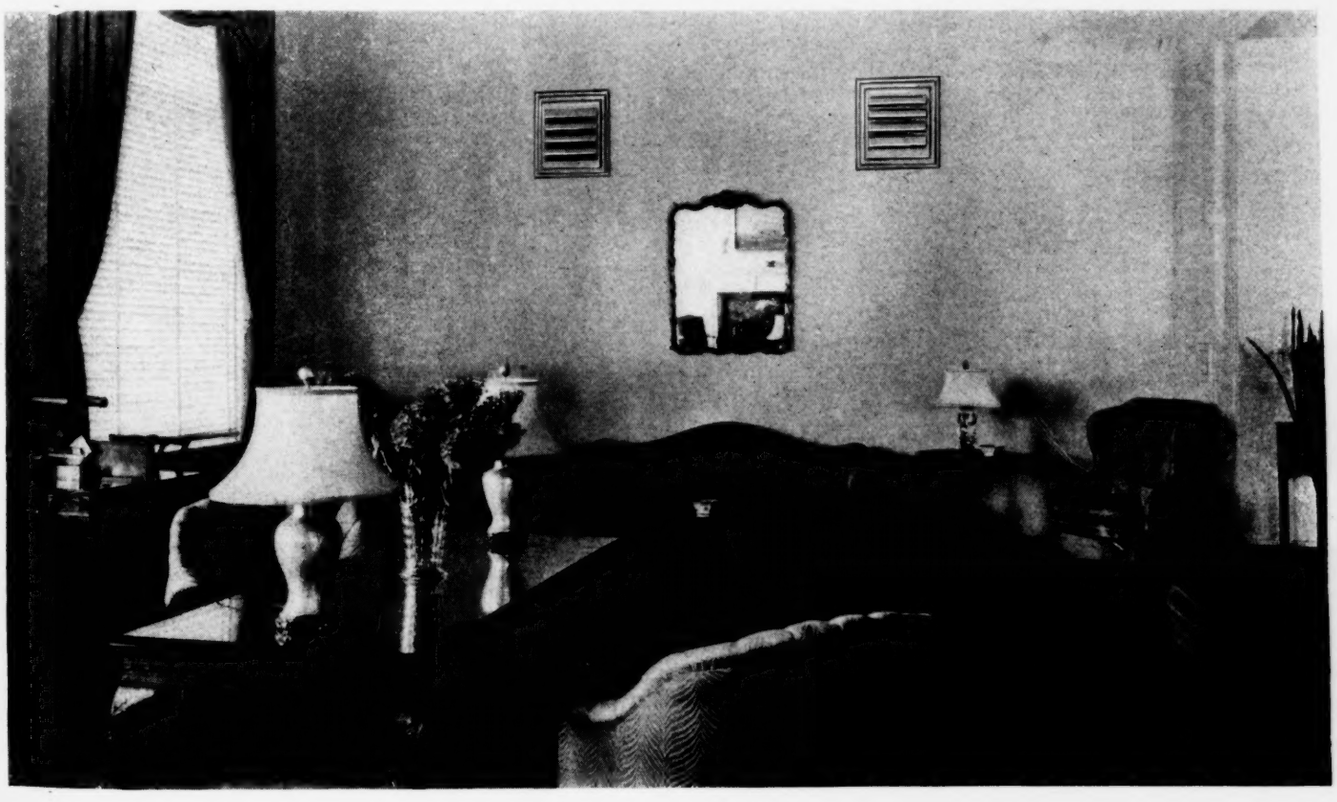


HEATING THE LEAGUE OF NATIONS BUILDING. The $15 million home of the League nearing completion in Geneva, Switzerland, has an oil-fired boiler, as shown above. The view below shows the fan room which is part of the elaborate air conditioning system. Photos by Swift.



E PARAGRAPHS

UNIT HEATERS IN HOTEL ROOM. (Below). Unit heaters are more and more being used for commercial and residential applications. Boston's Copley Square Hotel has six Fedders unit heaters, one cabinet housing the radio loudspeaker. Circulating ducts are placed within the walls and return grilles at the floor levels. The heaters have three-speed controls. The management is enthusiastic about the quiet operation as well as the uniform temperature maintained.



WITH THE MANUFACTURERS . . . . . .

The Allen-Bradley Co., Milwaukee, Wis., has appointed **S. A. Rhodes**, 2015 Main St., Cromwell, Conn., as representative in the Connecticut territory, replacing R. B. Soderberg.

American Gas Products Corp., New York, has appointed **H. H. Dugdale** vice-president in charge of sales. Mr. Dugdale has been general sales manager of the corporation since 1927. This company has also appointed **Harold Massey**, formerly sales engineer

H. H. Dugdale

Harold Massey

in the home office, to the position of assistant general sales manager. Mr. Massey entered the employ of American Radiator Company in 1930 as a designer of gas appliances.

Crane Co., Chicago, has established a division of research and development to maintain and enhance progress in its field and foster invention of new products. The research and development work formerly handled by various departments and subsidiaries will be expanded and centralized in the new division, which will be responsible directly to the president, with the vice-president of manufacture and the vice-president of sales acting in a coordinating capacity.

M. W. Link has been appointed director of the new division, and **B. A. Parks** will be assistant director. **C. A. Olson** will devote his time to heating, and **R. H. Zinkil**, research engineer,

B. A. Parks

M. W. Link

C. A. Olson

R. H. Zinkil

will be in direct charge of plumbing products. They will study characteristics and applications of various metals and materials to the company's products; originate new lines of products, and cooperate with the manufacturing department to produce new and improved products.

Julien P. Friez & Sons, Inc., Baltimore, Md., has appointed **Sheffler-Gross Co., Inc.**, Drexel Building, Philadelphia, Pa., as representative in the Philadelphia area.

Gorton Heating Corp., Cranford, N. J., has appointed **M. G. Limbach Co.**, 5005 Euclid Ave., Cleveland, as its representative in that territory.

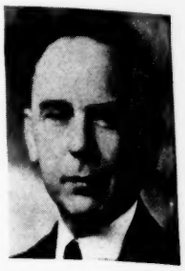
Kelvinator Corp., Detroit, Mich., has appointed the **Wittenmeier Machinery Co.**, Chicago, one of the oldest manufacturers of commercial refrigeration equipment in the country, as distributor for its air conditioning equipment in the Chicago territory. Entering the refrigeration business in 1903 with the first carbonic compressor made in this country, the Wittenmeier company started in the air conditioning business with a hotel installation in Chicago in 1908. It has specialized in hotel and theater installations. **Stephen Schotes** is president of the Wittenmeier company and **E. F. Bergman** is vice-president.

Link-Belt Co., Chicago, has moved its district sales office in St. Louis from 3638 Olive Street to 1018-21 Louderman Building, 317 North 11 Street. **Howard L. Purdon** is district sales manager.

National Fan & Blower Corp., Chicago, Ill., has appointed **K. E. Whitman** as vice-president and general sales manager. Mr. Whitman has been associated with the fan, blower and unit heater industry for the past 14 years.

National Radiator Corp., Johnstown, Pa., has appointed **T. A. Novotney** manager of convector sales. He will be located at 101 Park Ave., New York. Some years ago Mr. Novotney served as manager of the Buffalo branch sales office, which position he relinquished upon being appointed manager of the corporation's research department. He continued to serve as head of the research department until about a year ago, when he was appointed assistant to the general manager of sales, devoting most of his time to promoting the sale of convectors.

National Radiator Corp., Johnstown, Pa., has appointed **Nimrod H. Yates** manager of its Baltimore branch territory and **Paul B. Holmes** manager of the Washington branch territory. Mr. Yates has been in the service of the corporation since 1922, having been located at Salisbury, Md., for some years, while Mr. Holmes has served as a sales representative of the radiator concern in Washington since 1918. Both the Baltimore and Washington branch territories were under the supervision of a joint managership which was held for many years by the late John E. Jacob.



Norge Div., Borg-Warner Corp. Detroit, has appointed **George McIntyre**, Newark, N. J., vice-president in charge of national buyers' activities. He will also act in an advisory capacity on finance for Norge distributive organization. Mr. McIntyre maintains his connections as officer and director of several corporations affiliated with Beneficial Management Corporation.

Owens-Illinois Glass Co., Toledo, Ohio, has promoted **Stanley J. McGiveran**, manager of sales merchandising, to assistant general sales manager of all the company's divisions. Mr. McGiveran has been manager of sales merchandising since last June.

Pernot and Rich, Inc., manufacturer of air conditioning equipment, has moved to 2546 San Fernando Road, Los Angeles.

Geo. P. Reintjes Co., Kansas City, Mo., has appointed **Alex. Girtanner** as New York representative on the sale of its furnace wall and arch construction. His office is at 30 Church St.

Republic Steel Corporation has moved its general office force from Youngstown to Cleveland, where it will occupy floors 13 to 16 inclusive in the former Medical Arts Building, recently renamed the Republic Building. In addition to the numerous Republic departments affected by the change the sales offices of the **Newton Steel Company** will also be located in the Republic Building. The sales offices of the Alloy Steel Division of Republic will remain in Massillon, Ohio.

H. A. Thrush & Co., Peru, Ind., has appointed **Thos. S. Thibauld** as assistant to **James S. Blackmore**, the company's factory representative in the greater Philadelphia territory. Mr. Thibauld was formerly with Hart & Crouse and J. D. Johnson.

York Ice Machinery Corp., York, Pa., has elected **S. E. Lauer**, formerly general sales manager, vice-president in charge of sales. The promotion was announced at the annual meeting of the board of directors in January.

NEW EQUIPMENT

Nesbitt Heat Transfer Surface

NAME—Nesbitt heat transfer surface.

PURPOSE—For steam heating in blast systems and smaller applications.

FEATURES—Use of two internal tubes inside external tubes to which fins are attached. Exterior tube connects steam and return headers as does the smaller internal tube. The larger internal tube extends from the steam header one-half the length of the heater and is pierced with a number of small orifices through which steam is fed to the steam half of the finned or exterior tube. The smaller internal tube is similarly pierced for the half of its length which projects beyond the larger tube. All orifices are metered to admit the proper proportions of steam to each half of the heater. This together with proper spacing of the orifices is said to assure uniform steam distribution throughout the heater, regardless of steam pressure or quantity of steam supplied, and consequently gives air uniformly heated over entire face area of heater. While these tubes are new for fan system surface they have been used for five years in the radiators of unit ventilators made by the manufacturer.

MADE BY—*John J. Nesbitt, Inc., Holmesburg, Philadelphia, Pa.*

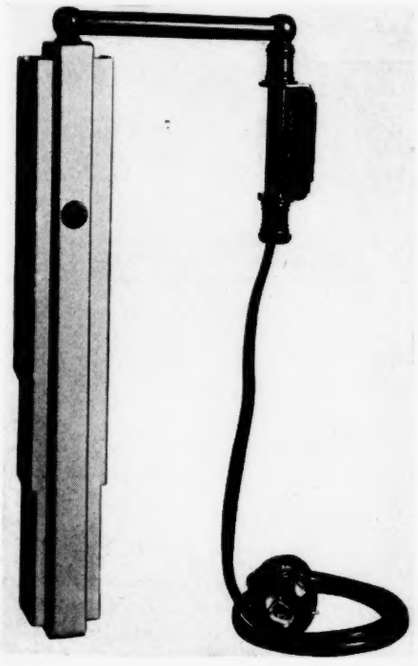
Friez Windowstat

NAME—Windowstat.

PURPOSE—To control excessive condensation on windows during cold weather.

FEATURES—Consists of humidity sensitive instrument in close proximity to the window and at a point where the sensitive element detects a too high moisture condition at that point. When this is reached the device through its electrical contacts overrules the wall humidistat and shuts down the humidifier until such time as further humidity can be added without condensation occurring. Can also be used in connection with a fan, in the case of display windows, to blow warm air over the window and increase the temperature and consequently the capacity of the window to carry condensation without moisture.

MADE BY—*Julien P. Friez & Sons, Inc., Baltimore, Md.*



York Industrial A.C. Unit

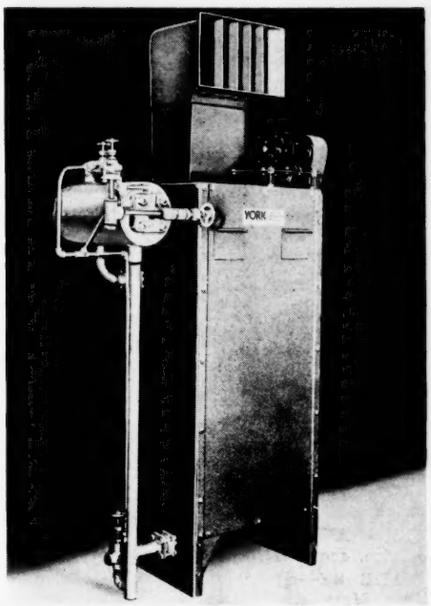
NAME AND MODEL NUMBER—Industrial air conditioning unit FB-500, FB-800, FB-1400, and FB-2000.

PURPOSE—Industrial air cooling with a maximum cooling effect and low operating cost.

FEATURES—Can be installed with or without distributing ducts. Furnished in either high or low operating types with automatic float control of refrigerant. Unit enclosed in heavy steel casing fully braced. Fans are of quiet operating multiblade, double inlet type providing low outlet velocities with V-belt drive. Cooling and dehumidifying surfaces are of ¾ in. full weight pipe, bent from single lengths and fabricated. After bending, coils are annealed to eliminate all internal strain. Thermostatic regulation of refrigeration operation is by control of flow of refrigerating element.

SIZES AND CAPACITIES—Wide range. Each unit has guaranteed rating.

MADE BY—*York Ice Machinery Corp., York, Pa.*



J-M Pipe Covering

NAME—Rock Cork pipe covering.

PURPOSE—Pipe insulation for cold lines.

FEATURES—Product of same basic material as Rock Cork sheets. Made up of waterproofed rock wool and has factory-applied waterproof jacket. Fittings are insulated with multiple layers of Zerotex, a waterproofed rock wool designed for the purpose.

MADE BY—*Johns-Manville Corp., New York, N. Y.*

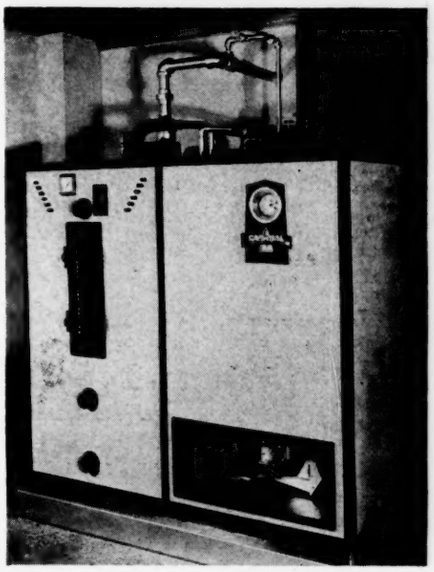
Inland Hi-Steel

NAME—Hi-Steel.

PURPOSE—A corrosion-resistant steel said to have a high degree of uniformity and physical characteristics as well as workability.

FEATURES—Has minimum yield point of 60,000 lb. per sq. in. for gages lighter than ¼ in., and 55,000 lb. in high strength. Minimum ultimate tensile strength is 70,000 lb. per sq. in.

MADE BY—*Inland Steel Co., Chicago, Ill.*



Gaskoal Pulverized Coal Boiler

NAME—Gaskoal unit.

PURPOSE—Building heating using pulverized coal.

FEATURES—Burns coal pulverized to a fineness of 93%, 200 mesh. Pulverized fuel is delivered to the storage hopper in the consumer's basement by a hose under 4-lb. pressure. After coal is stored in hopper it is fed by feeder using a toothed wheel which carries coal through tube where it is taken by vacuum into inlet of exhaust fan, then through flexible tubing to burner nozzle. Secondary air is supplied by exhauster through tube leading into burner assembly housing. Automatic thermostatic control. Gas flame acts as pilot and ignites pulverized fuel and air mixture.

MADE BY—*Gaskoal Corp., Chicago, Ill.*

Spencer Limit Control

NAME—Thermostatic control for bonnet, fan, and duct service.

FEATURES—Available in a low cost unit with a voltage range up to 250 volts. Has adjustable range and adjustable differential. Swivel mounting bracket. Is mounted with element in plenum chamber. Used as either high limit control or as fan switch to permit fan to operate only when heat is available.

MADE BY—*Spencer Thermostat Co., Attleboro, Mass.*

Power Takeoff for Welding

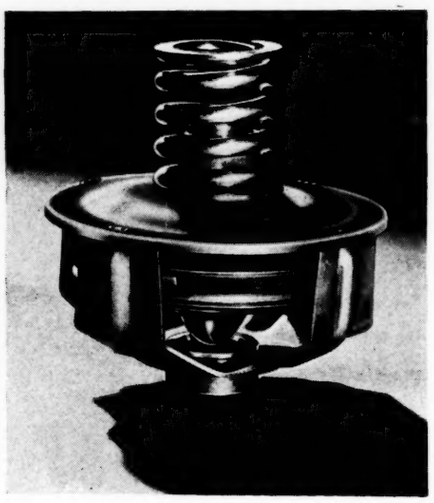
NAME—Power takeoff.

PURPOSE—For taking off power from motor truck for driving welding generator.

FEATURES—Adaptable to all makes and models of trucks. Can be controlled from the driver's seat by single lever. While welding, speed of the truck motor is controlled by a fly-ball type mechanical governor.

SIZES AND CAPACITIES—Power supplied by any leading make of 1½-ton truck is sufficient to drive a 200 or 300 ampere welding generator. Weighs 100 lb. installed. Transmits 120 brake horsepower at 2,800 r.p.m., 220 ft. lb. torque.

MADE BY—*The Hercules Steel Products Co., Galion, Ohio, in conjunction with The Lincoln Electric Co., Cleveland, Ohio.*



B. & J. Cage Unit for Traps

NAME—Barnes & Jones cage-unit.

PURPOSE—For replacement of thermostatic unit in radiator trap.

FEATURES—Complete thermostatic unit locked in adjustment with any radiator trap. Can be replaced easily and quickly by unskilled labor with no special tools and no adjustments.

MADE BY—*Barnes & Jones, Inc., Jamaica Plain, Boston, Mass.*

Syncro-Flame Oil Burner

NAME AND MODEL NUMBER—Mon-O-Unit Syncro-Flame model RH oil burner.

FEATURES—Simplicity of arrangement whereby the power plant of the burner can be replaced in less than 15 min. One end of motor shaft drives the pump to which are attached strainer and pressure regulating valve; other end is attached to fan.

MADE BY—*Syncro-Flame Burner Corp., Hartford, Conn.*

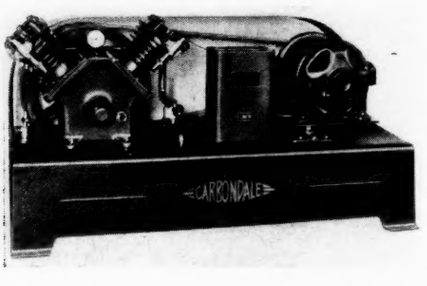
Carbondale Condensing Units

NAME—Full line of condensing units.

FEATURES—A full series of models designed for Freon and methyl chloride. Air cooled models have shrouded condensers and are suited for installations where adequate water supply is not available at a reasonable cost. Water cooled models of 3 hp. and over have horizontal shell and tube condensers mounted on a heavy welded base. These are particularly well suited to air conditioning requirements. They have V-type compressors of the heavy duty pattern with discharge and suction valves built on the feather valve principle, all located in the heads to secure even temperature. Motor starting box and automatic control are fully protected, wired, and piped, ready for main connections.

SIZES AND CAPACITIES—Line includes 18 sizes, from ¼ to 25 hp. Air cooled models are from ¼ to 2 hp. Water cooled models from ½ to 25 hp.

MADE BY—*Carbondale Machine Corp., Harrison, N. J.*



Shepard Stoker

NAME—Home Heater.

PURPOSE—A stoker for residential use.

FEATURES—Underfeed type stoker.

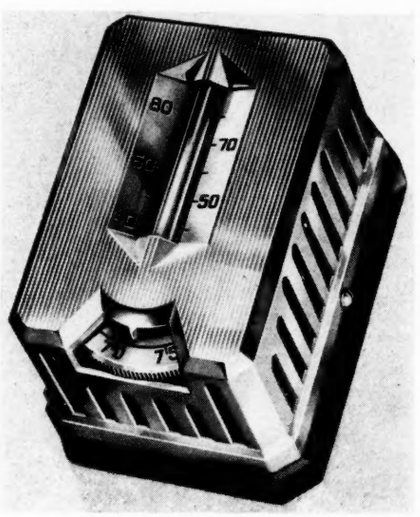
SIZES AND CAPACITIES—25 to 50 lb. of coal per hr.

MADE BY—*The Shepard Elevator Co., Cincinnati, Ohio.*

Spencer Thermostat

NAME—Room thermostat.

FEATURES—Concealed contacts to provide for protection from dust. Has dead front with no live parts exposed in thermostat. Available in three types. Standard, heat accelerator, and an outside compensated cooling control unit. Available with regular room mounting or with mounting accessories for special outlet box, conduit connection, wall plate for over-the-surface mounting, and standard switch box with plain or switch plate. Switch plate is a transfer switch for changing thermostat from winter heating to summer cooling control or reverse. Klixon disc thermostatic elements used. Available in five finishes: gold, chrome, brown lacquer, walnut



bakelite, and ivory plaskon.

SIZES AND CAPACITIES—For 250 volt service, 125 volt service, and 30 volt or less.

MADE BY—*Spencer Thermostat Co., Attleboro, Mass.*

Worthington Pump

NAME AND MODEL NUMBER—Monoblock type DH centrifugal pump.

PURPOSE—Hot well service and handling liquids near their vapor pressures. Intended for power plants, heating systems, and air conditioning and refrigeration plants and for handling volatile liquids against medium heads.

SIZES AND CAPACITIES—Compact. Overall floor space required by the largest model is 24 x 16 in. Capacities from 10 g.p.m. against heads of 50 to 110 ft. with 12 in. submergence; 175 g.p.m. against heads of 50 to 70 ft., with 60 in. submergence.

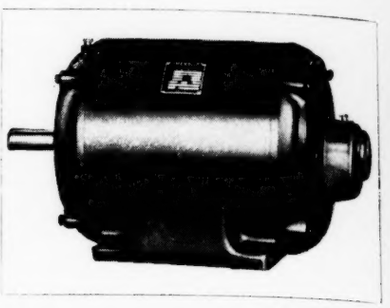
MADE BY—*Worthington Pump and Machinery Corp., Harrison, N. J.*

Stay-Rite Boiler Cleaner

NAME—Stay-Rite boiler cleaner.

PURPOSE—To remove oil and impurities present in new heating plants and in old systems when they have become clogged. Also said to stop priming and foaming.

MADE BY—*Stay-Rite Co., Inc., Cleveland, Ohio.*



Emerson Type SR Motor

NAME AND MODEL NUMBER—Type SR single phase motor.

PURPOSE—To meet demand for a single phase motor with a smooth torque-speed curve.

FEATURES—Efficient starting features of repulsion motors and the approximately constant-speed load operation of the induction motor. Suitable for such applications as air compressors, commercial refrigerators, pumps, and other devices which have a heavy starting load or in which starting is prolonged on account of excessive friction. Has armature with both squirrel cage winding and repulsion winding. Both windings operate as such at all times.

SIZES AND CAPACITIES—Available in 1, 1½, 2, and 3-hp. models. 1725 r.p.m.

MADE BY—*The Emerson Electric Mfg. Co., Inc., St. Louis, Mo.*

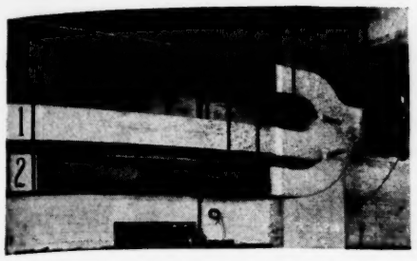
Anderson Air Eliminator

NAME—Air eliminator.

PURPOSE—For discharging air from the company's Super Silvertop inverted bucket steam traps.

FEATURES—Utilizes Spencer thermostatic disc. In cold position disc curves out and away from three large auxiliary ports on the side of the inverted bucket. Air can then pass through the trap. The eliminator remains wide open until the critical temperature is reached. It then snaps abruptly to closed position, covering the ports. Trap then operates normally. Consequently, eliminator is always either wide open for discharging air or tightly shut so that it is claimed there is no steam loss due to slow closing.

MADE BY—*V. D. Anderson Co., Cleveland, Ohio.*



(1) Conventional type air duct. (2) Zonolite air duct. (3) Zonolite air duct with insulation applied.

Zonolite Air Ducts and Insulation

NAME AND NUMBER—Zonolite air ducts and insulation.

PURPOSE—A sound insulation (Zonolite) of which a duct made of wire mesh of a special weave to replace the sheet metal type has been developed. To the wire mesh is applied the insulation, the insulation making a solid covering. Consequently, no sound absorbing liner is necessary, as the insulation meets this requirement. Zonolite is a micaceous, nonferrous, granular material of a bright golden color, with a thermal conductivity of 0.27, and in addition is efficacious as a sound insulator. The Zonolite is applied to the duct in two coats of ½ in. each. Other features include that of being fireproof, resistance of the insulation to part company with the wire mesh, and the ability to carry high air pressures. The complete duct is said to be less expensive than the conventional sheet metal duct with exposed insulation and a sound liner.

MADE BY—*The Zonolite Corp., Detroit, Mich.*

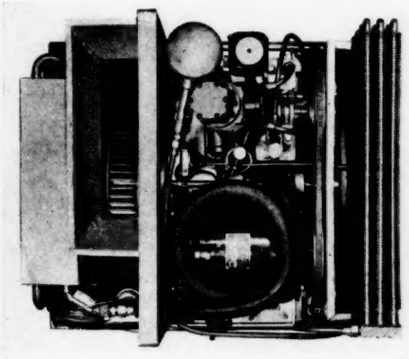
Thermal Units Window Type Cooling Unit

NAME AND MODEL NUMBER—Model V8 window type air conditioner.

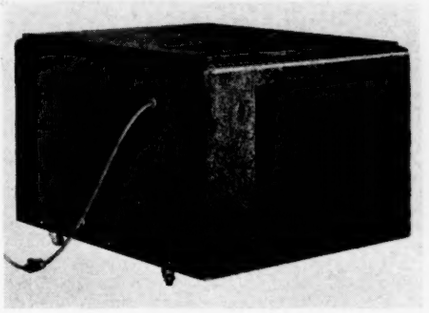
PURPOSE—Circulating, cleaning, cooling outside air for residential and commercial applications.

FEATURES—Can be plugged into convenient electrical outlet; requires no water or drain connections or ductwork to be installed in windows, the excess width of which can be blocked off with glass or wood.

DETAILS OF OPERATION—Return air is taken through large front grille shown at right of the illustration and discharged at the top of the unit. The window closes down over half of the cabinet just separating the high and low sides. There are two grilles with air intake to the condenser, one of which is shown at the left of the illustration. Outside air enters through these two grilles and discharged



Interior of V8 window type air conditioner.



Cabinet which houses V8 unit.

again to the outside air over the condenser, thus giving separation to the evaporator and condensing sections of the unit. Contains a V8 type cylinder compressor employing Freon refrigerant, blower fan and filter, as well as high side gage, oil tank and separator, strainer, and automatic high side cutout. A small water pump picks up moisture condensed by the evaporator leading it to a well beneath the pump intake; this water is then sprayed over the air cooled condenser to assist condenser cooling. Provided with casters so that it may be wheeled from room to room.

SIZES AND CAPACITIES—For installation where not more than ½-ton capacity is required. Weighs 240 lb. Size 26 in. x 24 in. x 16 in., ½-hp. motor.

MADE BY—*Thermal Units Manufacturing Co., Chicago, Ill.*

Friez Effectistat

NAME—Effectistat.

PURPOSE—In connection with a thermostat to maintain a constant effective temperature regardless of the variation in relative humidity.

FEATURES—Device is essentially a thermostat with a variable point of dry bulb control to suit the relative humidity existing at the moment. If the humidity rises the dry bulb control is automatically lowered in the correct ratio to maintain the effective temperature unchanged; if the relative humidity falls, the point of dry bulb is automatically set to maintain the correct ratio unchanged. Instrument consists of a bimetallic temperature element and multiple human hair sensitive humidity element.

MADE BY—*Julien P. Friez & Sons, Inc., Baltimore, Md.*

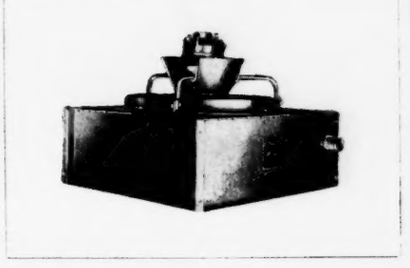
Wing Unit Heater

NAME AND MODEL NUMBER—Unit heater type G.

PURPOSE—Garage heating and similar large spaces.

FEATURES—Consists of combined electric and steam directional heater. Compact. Heat supplied from existing steam lines. Copper heating surface.

MADE BY—*L. J. Wing Mfg. Co., New York.*



Calrod Heating Unit

NAME—Calrod heating unit.

PURPOSE—For forced air heating of railway cars on electrified lines, building heating, and various types of unit heaters.

FEATURES—Consists of a steel-sheath Calrod heating element with steel fins copper-brazed to the steel sheath. The copper-brazing process provides thermal contact between the fins and the unit sheath and delivers an increased amount of heat in a given space for a given rating.

MADE BY—*General Electric Co., Schenectady, N. Y.*

Paragon Periodic Firing Control

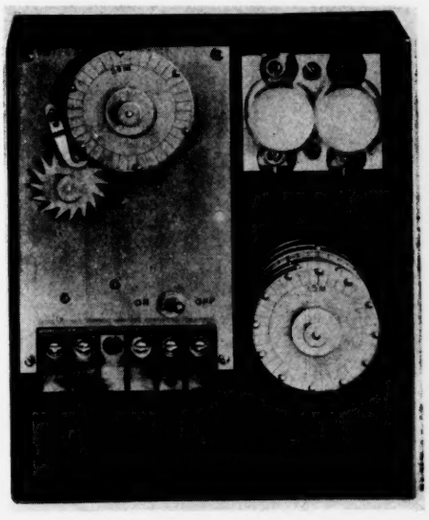
NAME AND MODEL NUMBER—Periodic firing control, model LSF.

PURPOSE—For regulating oil burners and stokers so that there is a delay between the cutoff and restart of the stoker or burner to level off the difference between the relatively rapid drop in boiler pressure or temperature as compared to the slower drop in room temperature.

DETAILS OF OPERATION—In the morning firing proceeds in usual way until desired room temperature is produced. During firing periods, periodic control is automatically disconnected from existing circuits. When desired boiler pressure is reached, pressure control stops stoker or burner in usual way. Opening of motor starter which stops burner or stoker immediately sets periodic firing control in operation. This control opens line through the normal restart position on pressure control and prevents heating unit from starting until set time delay has elapsed, at which time periodic control reestablishes the starting line, heating unit starts in usual way, and periodic control stops, resets, and is ready for next period. A double pilot light gives a visible figure through a glass bull's-eye in the case during the operating period and a cutoff switch is provided to disconnect the control when desired.

SIZES AND CAPACITIES—Synchronous motor operated wire for connection to 230 volts, 60 cycles a.c.; 115 volts and 50 cycle types also available.

MADE BY—*Paragon Electric Co., Chicago, Ill.*



Degree-Days for December, 1935

Continuing HEATING & VENTILATING's eighth year of publishing degree-day data for various large cities in the United States

	Atlanta, Ga.	Baltimore, Md.	Birmingham, Ala.	Boston, Mass.	Buffalo, N. Y.	Burlington, Vt.	Chicago, Ill.
Degree-days for December, 1935.....	881	1000	806	1176	1263	1448	1234
Degree-days, Sept. 1, '35 to Dec. 31, '35	1308	1699	1195	2237	2569	3006	2439
Degree-days, Sept. 1, '34 to Dec. 31, '34	1135	1535	942	2246	2344	2961	2155
Degree-days, Sept. 1 to Dec. 31, Normal	1131	1664	913	2130	2371	2772	2225

	Cincinnati, Ohio	Cleveland, Ohio	Columbus, Ohio	Denver, Colo.	Des Moines, Iowa	Detroit, Mich.	Dodge City, Kan.
Degree-days for December, 1935.....	1169	1180	1202	935	1267	1240	916
Degree-days, Sept. 1, '35 to Dec. 31, '35	2126	2259	2219	2262	2645	2558	2003
Degree-days, Sept. 1, '34 to Dec. 31, '34	1746	1998	1898	1928	2361	2324	1669
Degree-days, Sept. 1 to Dec. 31, Normal	1784	2185	2020	2276	2370	2332	1952

	Duluth, Minn.	El Paso, Tex.	Evansville, Ind.	Fort Wayne, Ind.	Grand Rapids, Mich.	Harrisburg, Pa.	Hartford, Conn.
Degree-days for December, 1935.....	1537	570	1087	1274	1208	1113	1151
Degree-days, Sept. 1, '35 to Dec. 31, '35	3829	1025	1861	2516	2527	2033	2197
Degree-days, Sept. 1, '34 to Dec. 31, '34	3524	817	1482	2229	2307	1890	2182
Degree-days, Sept. 1 to Dec. 31, Normal	3434	1038	1545	2220	2397	1981	2157

	Indianapolis, Ind.	Kansas City, Mo.	La Crosse, Wis.	Los Angeles, Calif.	Louisville, Ky.	Memphis, Tenn.	Milwaukee, Wis.
Degree-days for December, 1935.....	1215	1015	1384	173	1113	861	1261
Degree-days, Sept. 1, '35 to Dec. 31, '35	2268	2070	2964	342	1896	1437	2592
Degree-days, Sept. 1, '34 to Dec. 31, '34	1931	1786	2754	287	1531	1038	2398
Degree-days, Sept. 1 to Dec. 31, Normal	2002	1809	2778	424	1587	1127	2601

	Minneapolis, Minn.	Nashville, Tenn.	New Haven, Conn.	New Orleans, La.	New York, N. Y.	Norfolk, Va.	Oklahoma City, Okla.
Degree-days for December, 1935.....	1475	962	1132	433	1067	863	801
Degree-days, Sept. 1, '35 to Dec. 31, '35	3227	1597	2108	622	1883	1304	1589
Degree-days, Sept. 1, '34 to Dec. 31, '34	2938	1235	2045	376	1850	1147	1200
Degree-days, Sept. 1 to Dec. 31, Normal	2941	1363	2109	403	1849	1195	1379

	Omaha, Neb.	Peoria, Ill.	Philadelphia, Pa.	Pittsburgh, Pa.	Portland, Me.	Portland, Ore.	Providence, R. I.
Degree-days for December, 1935.....	1172	1297	1039	1133	1258	708	1151
Degree-days, Sept. 1, '35 to Dec. 31, '35	2580	2528	1768	2083	2584	1782	2190
Degree-days, Sept. 1, '34 to Dec. 31, '34	2195	2133	1623	1906	2606	1448	2159
Degree-days, Sept. 1 to Dec. 31, Normal	2284	2323	1733	1949	2496	1724	2129

	Reading, Pa.	Richmond, Va.	Rochester, N. Y.	St. Louis, Mo.	Salt Lake City, Utah	San Francisco, Calif.	Scranton, Pa.
Degree-days for December, 1935.....	1095	983	1260	1076	1015	374	1230
Degree-days, Sept. 1, '35 to Dec. 31, '35	1975	1589	2517	2000	2268	971	2404
Degree-days, Sept. 1, '34 to Dec. 31, '34	1856	1436	2337	1600	2031	775	2225
Degree-days, Sept. 1 to Dec. 31, Normal	2014	1406	2414	1738	2149	949	2274

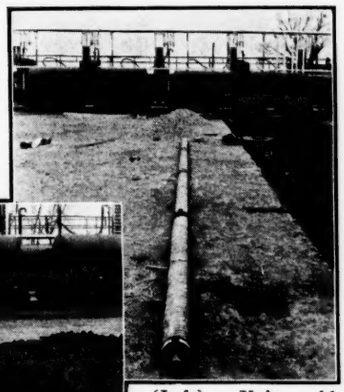
	Seattle, Wash.	Spokane, Wash.	Syracuse, N. Y.	Toledo, Ohio	Trenton, N. J.	Washington, D. C.	Wichita, Kan.
Degree-days for December, 1935.....	619	1046	1292	1246	1107	1020	934
Degree-days, Sept. 1, '35 to Dec. 31, '35	1777	2660	2550	2476	1988	1737	1946
Degree-days, Sept. 1, '34 to Dec. 31, '34	1587	2325	2348	2201	1879	1599	1585
Degree-days, Sept. 1 to Dec. 31, Normal	1881	2583	2491	2189	1760	1741	1783

Unit fuel consumption figures will be omitted from this month on so that degree-day figures on eight additional cities may be included. To obtain unit fuel consumption figures for December for any city shown above, multiply the December degree-days by the following factors: for coal, 0.008; for oil, 0.00068; for gas, 0.096. Figures obtained will show coal consumption in pounds per square foot of radiator surface; oil consumption in gallons per square foot; gas consumption in cubic feet per square foot. The figures assume the use of steam radiators emitting 240 B.t.u. per sq. ft. per hr., a system operation at 100% efficiency, and radiators calculated for maintaining 70° in zero weather. Heating values assumed for the fuels are 12,000 B.t.u. per lb. for coal; 140,000 B.t.u. per gal. for oil, and 1,000 B.t.u. per cu. ft. for gas. To correct for other heating values, efficiencies, and design conditions, follow the method explained in the "HEATING & VENTILATING Degree-day Handbook." Degree-days as given above for "a normal" month or season are based on averages for a long period of years, ending about 1922. Averages covering different periods will disagree with the above figures slightly.

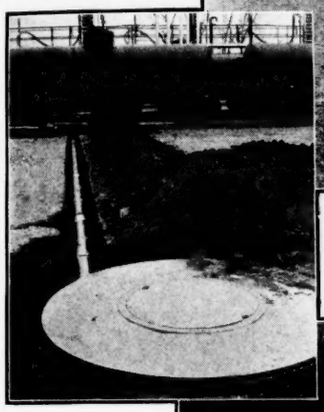
UNDERGROUND STEAM PIPING WITH CONDUIT AND INSULATION

COMPLETE

Ready to Install!



(Right) Part of 95 Units as delivered and ready for installation. Note that Ric-wiL Unit Steam Main has plenty of supporting strength for use under railroads.



(Left) 3 Units welded together above ground, ready for backfill, showing Ric-wiL pre-fabricated Unit Manhole, with self-contained expansion device.

(Right) Close-up view, unretouched, of conduit in trench, with asphalt coating applied, and connector liner raised to show Dry-paC insulation—ready for final installation of conduit Connector band.

THESE pictures show a recent installation of Ric-wiL Unit Steam Main for an industrial concern. A durable, compact, light-weight System designed for economy and speed. Completely assembled at the factory, including pipe and supports, insulation, liner, and Armco Iron conduit, ready to install, with welder and common labor. Shipped in units 13 1/2 feet long. Famous genuine Dry-paC Waterproof Asbestos insulation. Trenching reduced to an absolute minimum. Reclamation value practically 100% — can be moved and installed elsewhere. Total installed cost is the lowest for any satisfactory job. Utility test reports and complete details on request.

The Ric-wiL Co., Union Trust Bldg., Cleveland, Ohio
New York • San Francisco • Chicago

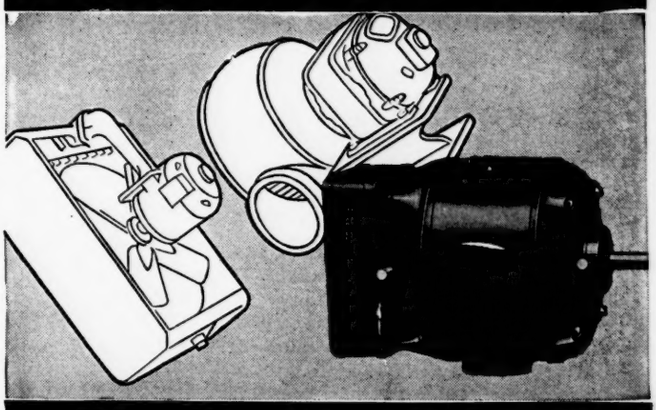
Agents in principal cities

REGISTERED IN U. S. PATENT OFFICE

RIC-WIL

CONDUIT SYSTEMS FOR UNDERGROUND STEAM PIPES

The name BALDOR



stands ace high in the HEATING and AIR CONDITIONING INDUSTRY

Baldor was first to develop specially designed motors for Unit Heater and Air Conditioning Service.

Baldor was first to introduce and perfect Variable Speed Condenser Type motors for Fan and Air Conditioning application.

● LATEST BULLETINS containing complete technical data on Baldor motors, specifications and other helpful information sent upon request.

BALDOR ELECTRIC COMPANY

4356 DUNCAN AVE. • ST. LOUIS, MO.

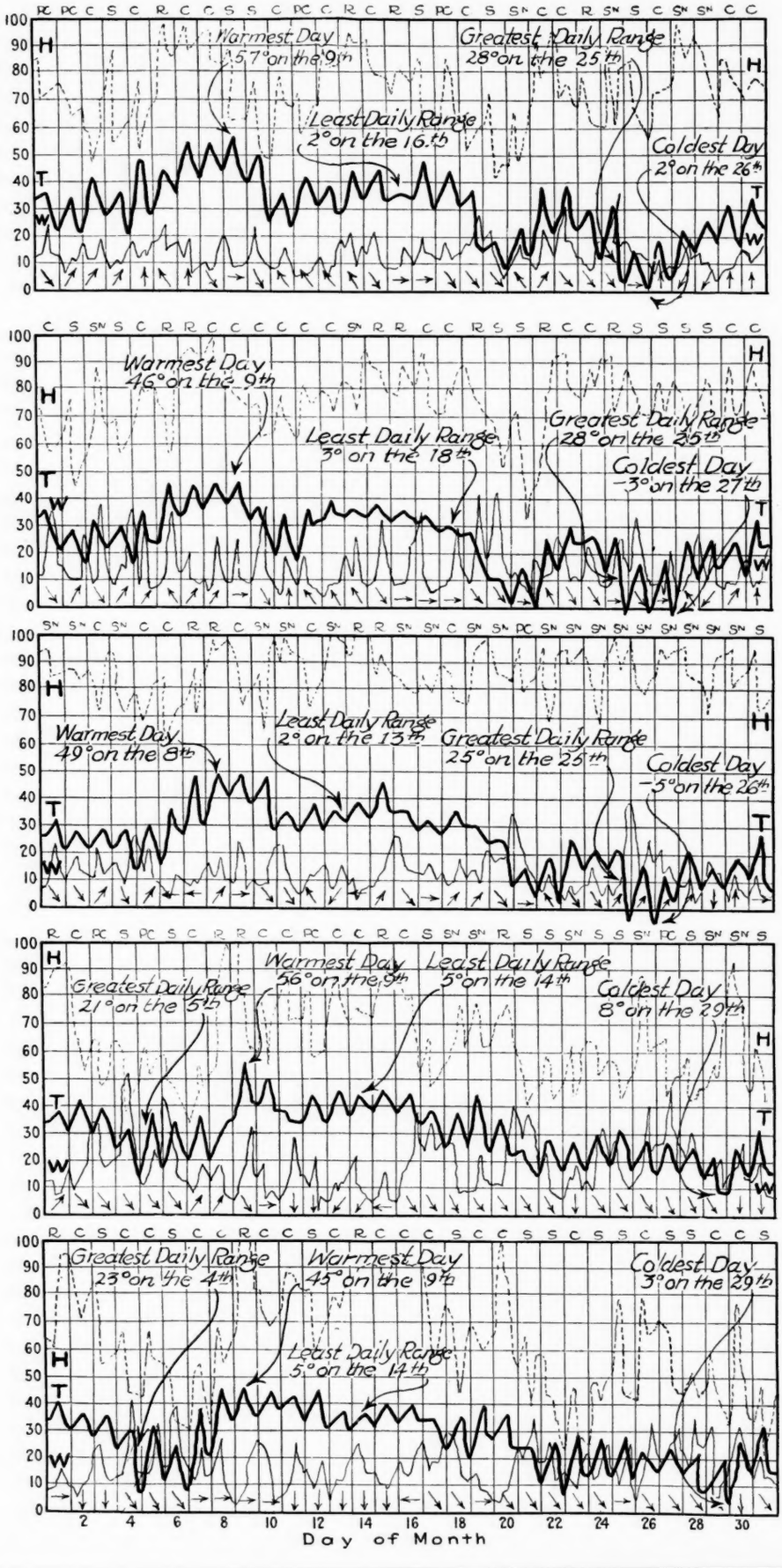
New York	14 E. 17th St.	Milwaukee	3331 N. 50th St.
Chicago	325 W. Huron St.	Philadelphia	2019 Rittenhouse
Detroit	1034 St. Aubin	Pittsburgh	1438 Park Blvd.
Buffalo	22 Kenton Rd.	Minneapolis	Vendome Hotel
Boston	31 Irvington	Grand Rapids	257 Eastern Ave. S.E.
		Kansas City	2004 Grand Ave.

BALDOR

A BETTER MOTOR

THE WEATHER FOR DECEMBER, 1935

Plotted from records compiled for HEATING AND VENTILATING by the U. S. Weather Bureau. Heavy curves (T), dry bulb temperatures in deg. F. dotted lines (H), per cent relative humidity, from readings at 8 a.m., noon, and 8 p.m., except for New York, which shows hourly readings. Light lines (W), wind velocity in m.p.h. Arrows indicate prevailing wind directions. S—clear; PC—partly cloudy; C—cloudy; R—rain; Sn—snow.


Warmest Day 57° on the 9th
Greatest Daily Range 28° on the 25th
Least Daily Range 2° on the 16th
Coldest Day 2° on the 26th
Warmest Day 46° on the 9th
Least Daily Range 3° on the 18th
Greatest Daily Range 28° on the 25th
Coldest Day -3° on the 27th
Warmest Day 49° on the 8th
Least Daily Range 2° on the 13th
Greatest Daily Range 25° on the 25th
Coldest Day -5° on the 26th
Greatest Daily Range 21° on the 5th
Warmest Day 56° on the 9th
Least Daily Range 5° on the 14th
Coldest Day 8° on the 29th
Greatest Daily Range 23° on the 4th
Warmest Day 45° on the 9th
Least Daily Range 5° on the 14th
Coldest Day 3° on the 29th
H
T
W
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Day of Month

St. Louis

Mean temp. for month, 30.3°; aver. wind velocity, 12.0 m.p.h.; prevailing direction of wind, NW.

Chicago

Mean temp. for month, 25.2°; aver. wind velocity, 10.6 m.p.h.; prevailing direction of wind, NW.

Pittsburgh

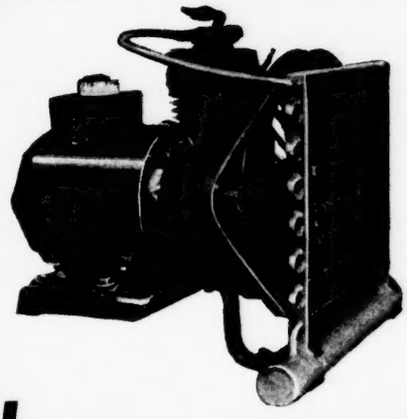
Mean temp. for month, 24.8°; aver. wind velocity, 11.4 m.p.h.; prevailing direction of wind, SW.

New York

Mean temp. for month, 30.6°; aver. wind velocity, 16.2 m.p.h.; prevailing direction of wind, NW.

Boston

Mean temp. for month, 27.1°; aver. wind velocity, 15.2 m.p.h.; prevailing direction of wind, NW.



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are Well-Designed

Wagner motors conform to refrigerator and air-conditioner manufacturers' demands for auxiliary equipment that harmonize with the arrangement, utility, and construction of their equipment.

Every single item that has a definite bearing on the appearance of Wagner motors contributes to its mechanical efficiency. Drip-proof end-plates, for example (see Photo N445), protect the motor from falling dirt and liquids, and protect individuals from contact with moving parts. Ample ventilation is secured from openings located underneath the bearing housings.

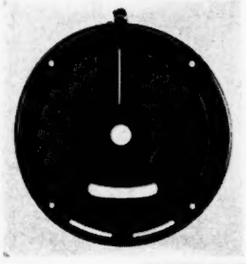

PHOTO N445

All parts and completed motors undergo careful and thorotests according to all N. E. M. A. specifications,—your assurance of reliable, quiet, trouble-free, quality motors. Photo K1261 shows a view of one of the test boards with a motor undergoing tests.

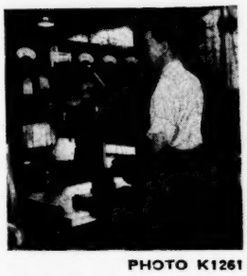

PHOTO K1261

Wagner Bulletin 177, which completely describes the construction features of Wagner small motors, will be sent upon request.

S635-5B

Wagner Electric

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TRANSFORMERS
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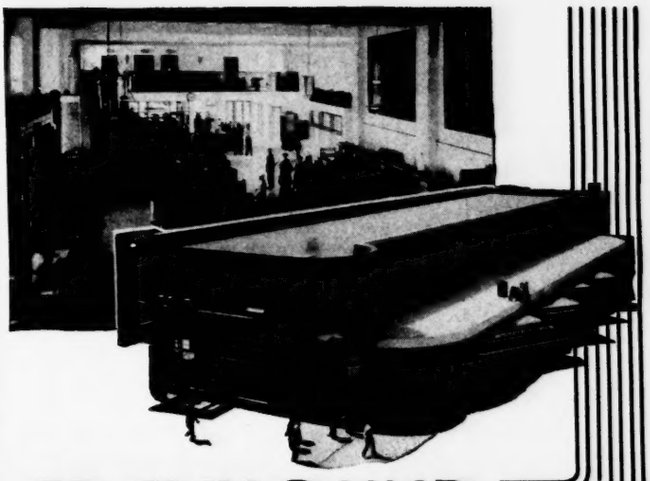

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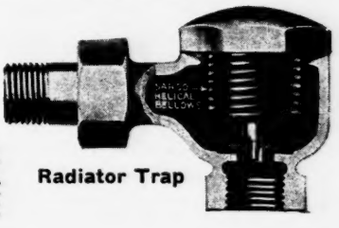

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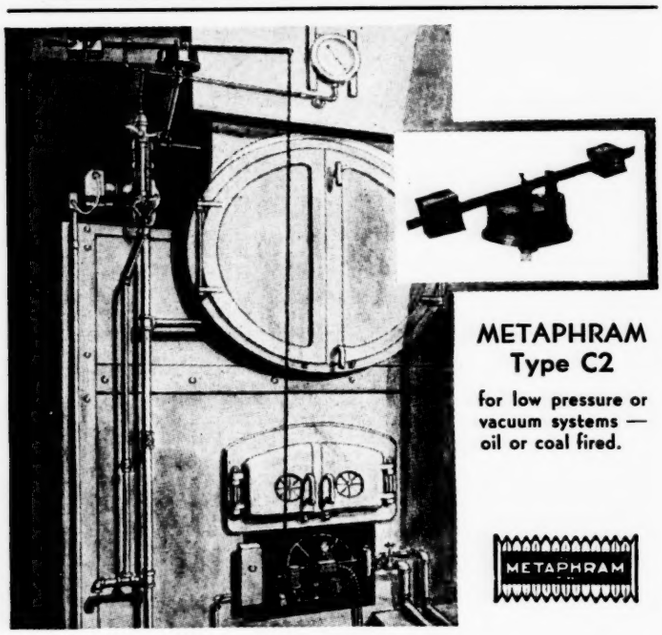

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NEW CATALOGS

Unless otherwise indicated the publishers of catalogs will supply copies on request without charge.

American Blower Corp., Detroit, Mich., has published bulletin A5018 entitled Venturafin Unit Heater Catalog and Engineering Application Guide. An unusual feature of the book is that the capacity tables for the various unit heaters give decibel ratings for each unit at various speeds. The book is profusely illustrated, attractively presented, and contains considerable engineering data, such as heat loss tables, information on proper location of units, piping connections, pipe sizes, etc. Standard size, 48 pages.

The American Brass Co., Waterbury, Conn., has published its catalog B-21 entitled Anaconda Beryllium Copper. Engineering and scientific data as well as a large amount of application data regarding this product are included. Beryllium imparts to copper the advantages of fatigue and corrosion and wear resistance so that the resulting alloy is applicable to diaphragms, bellows, and similar products. Standard size, 20 pages.

Armstrong Machine Works, Three Rivers, Mich., has published a data book on greenhouse heating entitled "What Every Greenhouse Man Should Know About Steam Traps." Detailed information on the size, installation, and type of trap best suited for various greenhouse heating systems is plentifully illustrated with charts and diagrams. Both the drawings and explanations have been reduced to simple terms in order that they may be understood clearly by readers, regardless of technical knowledge. Standard size, 12 pages.

Autovent Fan & Blower Co., 1805-1827 No. Kostner Ave., Chicago, has published its performance data and price sheet F-250 for 1936 covering its complete line of propeller fans and accessory equipment. The company's 31 series propeller fan and B-W propeller fan are featured. Standard size, six pages.

Julien P. Friez & Sons, Inc., Baltimore, Md., has published bulletins C and C/1 describing in detail the company's Hytherstats and Comfortrols. The former is standard size, six pages, punched for loose leaf. The latter is a two-page supplement consisting of wiring diagrams.

The Ilg Electric Ventilating Co., Chicago, has published a 14-page booklet reprinting a talk given before the Boston Air Conditioning Bureau by P. D. Briggs, vice-president of Ilg, on "Sensible Ventilating—A Phase of Air Conditioning." Size 3⅞ x 9 in.

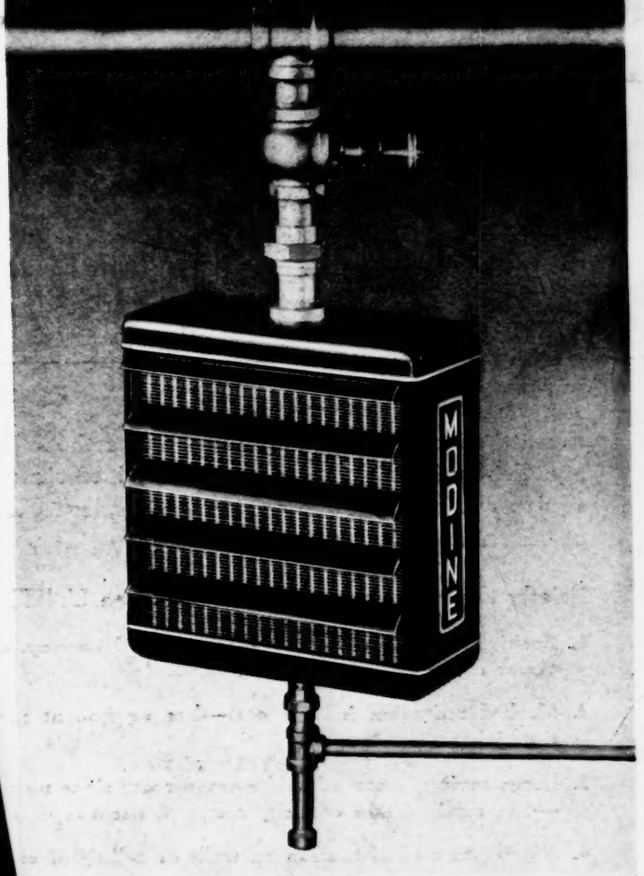
Inland Steel Co., 38 South Dearborn St., Chicago, has published a new fifth edition of its booklet "Sizes We Roll." Includes complete size data on all sheets, strip, bars, plates, structurals and semi-finished steel produced by Inland, and also several reference tables useful in ordering steel. Pages loose leaf punched. Size 3¾ in. x 8½ in., 64 pages.

Knowles Mushroom Ventilator Co., 41 North Moore St., New York, has published a catalog on its air diffusers of various types. Descriptions, capacity, and dimensional data are given of the company's mushroom air diffuser, of the Aerovalve, Nu-Notch type, the Disc-Loc riser type ventilator, and the aisle hood type air deflector. Includes a large list of auditoriums in which these products have been installed. Standard size, 8 pages.

The Safety Car Heating & Lighting Co., New York, has published a standard size, 24-page booklet entitled "The Carrier-Safety System for Air Conditioning Railway Passenger Cars—Steam Ejector Equipment." Included are numerous photographs of the various types of this apparatus, together with descriptions of the principles, steam consumption, capacities, controls, methods of operating, and auxiliary equipment, as well as detailed drawings of all the parts, together with piping and wiring diagrams.

Wagner Electric Corp., St. Louis, Mo., has published the Wagner fan bulletin for 1936, No. 178. New items added to the company's line and illustrated in the catalog are a 10-in. popular-priced oscillator, a 10-in. window ventilator, and a 24-in. air circulator, and a line of exhaust fans. Profusely illustrated. Standard size, 16 pages.

Don't Jeopardize the Future of your business



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